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Control of Industrial VOC (Volatile Organic Compound) Emissions by Catalytic Incineration. Volume 5. Catalytic Incinerator Performance at Industrial Site C-3

Radian Corp., Durham, NC

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CONTROL OF INDUSTRIAL VOC EMISSIONS BY CATALYTIC INCINERATION

Volume 5. Catalytic Incinerator Performance at Industrial Site C-3

by

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16. ABSTRACT

The report is part of a two-phase EPA effort to assess the performance, suitability, and costs of various technologies to control emissions of volatile organic compounds (VOCs). In Phase 1, information was assembled from the literature on the use and cost of using catalytic incineration for VOC control. Results included: (1) a review of current and developing catalytic incineration technology, (2) an assessment of the overall performance of catalytic incinerators, (3) a review of applications where catalytic incinerators are used, (4) a comparative analysis of catalytic incineration with other competing VOC controls, (5) an examination of available methods for emission testing catalytic incinerators, and (6) an assessment of the need for additional performance test data. Phase 2 was a test program designed to increase the catalytic incinerator performance data base. It resulted in reports documenting the performance of eight catalytic incinerators at six industrial sites. The incinerators were used to control VOC emissions from solvent evaporation processes at can coating, coil coating, magnet wire, and graphic arts printing plants. Performance was measured at several process conditions at each site. Incinerator performance was characterized in terms of destruction efficiency, outlet solvent concentration, and energy usage. Design and operating data were collected.

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17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group	
Pollution	Magnet Wire	Pollution Control	13B	11F, 20C
Incinerators	Graphic Arts	Stationary Sources		14E
Catalysis	Printing Equipment	Catalytic Incineration	07D	
Organic Compounds		Volatile Organic Compounds	07C	
Volatility			20M	
Solvents		Solvent Evaporation	11K	
Evaporation		Can Coating		

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ABSTRACT

The emission of volatile organic compounds (VOCs) from industrial plants significantly increases ambient levels of photochemical oxidants, ozone, and smog. Control of industrial VOC emissions, therefore, can result in substantial environmental benefits. This study was part of a comprehensive effort by EPA/IERL-RTP to assess the performance, suitability and costs of various VOC control technologies. The objectives of the EPA program were two-fold:

(1) to provide an overview of how catalytic incineration is applied to control industrial VOC emissions and to assess the overall performance, applicability, and costs as compared to alternate VOC control technologies, and

(2) to gather actual performance data through a field testing program on existing operating industrial catalytic incinerators.

The task of meeting these objectives was accomplished in two phases. In the first phase, information was assembled from the literature on the use and cost of using catalytic incineration for VOC control. This phase of the study provides results in the following areas:

- A review of current and developing catalytic incineration technology,
- an assessment of the overall performance of catalytic incinerators,
- a review of applications where catalytic incinerators are used,
- a comparative analysis of catalytic incineration with other competing VOC controls,
- an examination of the available methods for emission testing catalytic incinerators, and
- an assessment of the need for additional performance test data.

The second phase was a testing program designed to increase the catalytic incinerator performance data base. The testing program was planned so that 8 catalytic incinerators at industrial sites would be tested.

The outputs from this phase of the program consisted of a series of reports documenting the performance of 8 catalytic incinerators at 6 industrial sites. All 8 incinerators were used to control VOC emissions from solvent evaporation processes. Incinerators at can coating, coil coating, magnet wire, and graphic arts printing plants were tested. The performance measurements were made at several process conditions at each of the sites visited. Incinerator performance was characterized in terms of destruction efficiency, outlet solvent concentration, and energy usage. Incinerator design and operating data, such as operating temperature, solvent type, catalyst volume and age, were collected to document the operating conditions during the tests.

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SECTION 1

INTRODUCTION

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Radian Corporation is conducting a testing program for the U.S. Environmental Protection Agency (EPA Contract No. 68-02-3171, Work Assignment 50) to evaluate the performance of catalytic incinerators that have been applied to industrial processes for volatile organic compound (VOC) control. VOC emissions are of concern because they may react in the atmosphere to form photochemical oxidants, the levels of which routinely exceed National Ambient Air Quality Standards (NAAQS) in many areas of the United States. Since VOC's contribute to the ambient oxidant levels, the reduction of VOC emissions can provide significant improvements in ambient air quality. For the purpose of discussion, the term VOC is used throughout this report to mean any volatile organic compound in the gas stream sampled.

The approach taken to evaluate the performance of industrial catalytic incinerators as VOC control devices consisted of (1) developing plant-specific test plans and test methods to characterize the performance of several incinerators, (2) performing several days of comprehensive on-site testing of each incinerator, and (3) evaluating the performance data to determine VOC destructon efficiency as a function of incinerator operating conditions.

The current program includes testing conducted at six test sites, each of which is the subject of an individual report (Volumes 3-8). This report presents test results and data evaluation for the testing conducted at the third test site, which involved the testing of two catalytic incinerators at Plant C-3, a graphic arts printing establishment. The data presented in this report apply only to Plant C-3. Comparative data from other sites are not included; however, a final project report (Volume 2) includes comparative results.

This report provides a summary of the results of the third test series in Section 2.0. Section 3.0 provides a process description and Section 4 discusses the test methods. The results of testing and analysis are presented and discussed in Section 5.0. Detailed test results are appended.

SECTION 2

SUMMARY

As part of an EPA research program, Radian Corporation is evaluating the performance of catalytic incinerators used to control VOC emissions from surface coating operations. The program focuses on the field testing of several incinerator systems to characterize VOC destruction efficiency as a function of incinerator operating conditions. This section of the report summarizes the results of the performance evaluation of two catalytic incinerators operated by Plant C-3, a graphic arts printing establishment.

Incinerators 20 and 21 at Plant C-3 control solvent VOC emissions (primarily C_{12}-C_{18} hydrocarbons) from web offset printing presses. Incinerators 20 and 21 process nominally 1.3 Nm^3/sec and 2.2 Nm^3/sec (2700 scfm and 4600 scfm) solvent-laden air (SLA) streams, respectively. The incinerators are fired with natural gas and normally operate with average catalyst temperatures of about 371°C (700°F) as controlled by the natural gas flow rate. Both incinerators use a recuperative heat exchange arrangement to minimize auxiliary flue gas consumption.

The incinerators' performance was evaluated at different catalyst operating temperatures and for different inlet VOC concentrations. The following major analyses were performed during the test program, which was conducted in January, 1983:

- VOC analysis--inlet and outlet VOC's were quantified and/or identified using (1) EPA Proposed Reference Method 25A (total hydrocarbon analysis), (2) EPA Draft Reference Method 18 (speciated hydrocarbon analysis), and (3) gas chromatography/mass spectrometry (GC/MS) techniques;
- CO analysis--outlet CO concentrations were measured using a state-of-the-art semi-continuous emissions analyzer;

- Flow measurements--inlet and outlet gas flow rates were determined using standard procedures to provide VOC mass flow data for VOC destruction efficiency calculations; and
- Other process measurements--miscellaneous performance parameters were measured or monitored to fully characterize incinerator operation.

Results of the testing performed using these analyses are summarized in Tables 2-1 and 2-2 for incinerators 20 and 21, respectively. The results are categorized by test number, which correspond to different catalyst temperature setpoints.

In comparing the tabulated operating characteristics of the two incinerators, it is seen that the age of the catalyst during the test program in incinerator 21 was about half of that of the incinerator 20 catalyst (1.3 years vs. 0.7 year). This fact may have at least partially accounted for the correspondingly higher catalyst temperature rise (inlet to outlet) for incinerator 21, which averaged about 40°C (72°F) as compared to an average of less than 10°C (18°F) for incinerator 20. That is, the older catalyst in incinerator 20 may have less effectively promoted VOC oxidation, resulting in less VOC destruction and heat release as compared to incinerator 21.

This observation is consistent with the VOC total hydrocarbon (THC) destruction efficiency as determined by EPA Proposed Reference Method 25A. The tabulated data indicate that, for similar inlet THC concentrations and catalyst temperature setpoints (e.g., Test 2 for both incinerators), THC destruction efficiency was significantly lower for incinerator 20 than for incinerator 21--84 percent vs 95 percent. Comparative THC data for the three tests performed for each incinerator indicate that THC destruction efficiency increased with inlet THC concentration and catalyst temperature setpoint for the range of conditions tested, although the relationship was much less pronounced for incinerator 21.

TABLE 2-1. SUMMARIZED PERFORMANCE RESULTS--INCINERATOR 20

Parameter (Average Values Presented)	Test 1	Test 2	Test 3
Operating Characteristics			
Catalyst age	1.3 years	1.3 years	1.3 years
Catalyst temperature setpoint	371° (700°F)	385°C (725°F)	399°C (750°C)
Product ID	A	A	A
Catalyst temperature rise	7°C (12°F)	9°C (16°F)	10°C (18°F)
SLA flow rate	1.26 Nm^3/sec (2660 scfm)	1.27 Nm^3/sec (2680 scfm)	1.23 Nm^3/sec (2600 scfm)
Natural gas flow rate[a]	0.0052 Nm^3/sec (11 scfm)	0.0057 Nm^3/sec (12 scfm)	0.0061 Nm^3/sec (13 scfm)
Total Hydrocarbon Analysis (Proposed EPA Reference Method 25A)[b]			
Inlet THC concentration	1240 ppmc	1530 ppmc	1690 ppmc
Outlet THC concentration	241 ppmc	248 ppmc	227 ppmc
THC destruction efficiency	80.1%	83.8%	86.6%
Speciated Hydrocarbon Analysis (Draft EPA Reference Method 18)[b]			
Inlet THC concentration	all tests	1850 ppmc	
Outlet THC concentration		410 ppmc	
THC Destruction Efficiency		78%	
GC/MS VOC Analysis			
Inlet species	all tests	C_7-C_{17} aliphatics, benzene, and toluene	
Outlet species		C_7-C_{17} aliphatics, benzene, toluene, furan, and C_4-C_{12} alkenes	
Outlet CO Concentration	500 ppmc	540 ppmc	--[c]

[a] Estimated from an energy balance.

[b] Data represent steady-state press/incinerator operation.

[c] CO analysis was not performed during steady-state operation.

TABLE 2-2. SUMMARIZED PERFORMANCE RESULTS--INCINERATOR 21

Parameters (Average Values Presented)	Test 1	Test 2	Test 3
Operating Characteristics			
Catalyst age	0.7 year	0.7 year	0.7 year
Catalyst temperature setpoint	371°C (700°F)	385°C (725°F)	399°C (750°F)
Product ID	B, C	C, D	E, F
Catalyst temperature rise	54°C (97°F)	28°C (51°F)	41°C (74°F)
SLA flow rate	2.21 Nm^3/sec (4670 scfm)	2.17 Nm^3/sec (4600 scfm)	2.14 Nm^3/sec (4530 scfm)
Natural gas flow rate[a]	0.0043 Nm^3/sec (9 scfm)	0.0061 Nm^3/sec (13 scfm)	0.0061 Nm^3/sec (13 scfm)
Total Hydrocarbon Analysis (Proposed EPA Reference Method 25A)[b]			
Inlet THC concentration	3400 ppmc	1800 ppmc	2660 ppmc
Outlet THC concentration	147 ppmc	96 ppmc	106 ppmc
THC destruction efficiency	95.7%	94.6%	96.0%
Speciated Hydrocarbon Analysis (Draft EPA Reference Method 18)			
Inlet THC concentration	all tests	1410	
Outlet THC concentration		180	
THC destruction efficiency		87%	
GC/MS VOC Analysis			
Inlet Species	all tests	C_7-C_{17} aliphatics, benzene and toluene	
Outlet species		C_4-C_{17} aliphatics, benzene, toluene, furan, and C_4-C_{12} alkenes	
Outlet CO Concentration	1030 ppmc	490 ppmc	440 ppmc

[a] Estimated from an energy balance.

[b] Data represent steady-state press/incinerator operation.

Using EPA Draft Reference Method 18, analysis of natural gas species and $C_{12}-C_{18}$ hydrocarbon species was attempted. Qualitative data were obtained indicating little or no change in the relative distribution of inlet solvent species being introduced to the incinerator. Of major significance was the survival through the incineration process of some light hydrocarbons from the natural gas. A significant portion of the nonmethane organics measured in the outlet by Method 18 were of natural gas origin, with little or no heavy organics ($C_{12}-C_{18}$) being present.

Gas chromatograph/mass spectroscopy (GC/MS) results indicated that the major species in both inlet and outlet samples were $C_{13}-C_{17}$ aliphatics, benzene, and toluene.

During most of the test period, CO emissions in the incinerators' exhaust streams averaged nominally 500 ppmc. One test of incinerator 21, however, was characterized by CO exhaust levels in excess of 1000 ppmc. These higher CO exhaust emissions are attributed to the significantly greater inlet VOC loadings and lower temperatures of this test as compared to the other tests.

SECTION 3

PROCESS DESCRIPTION

Plant C-3 produces graphic arts, primarily magazines and brochures, by web offset printing. The offset printing process uses inks containing a heavy organic solvent of C_{12} through C_{18} hydrocarbons, which is evaporated as the printed paper web dries. The vaporized solvent emissions from printing lines 20 and 21 at Plant C-3 are controlled by catalytic incineration.

A general description of the printing operation is presented in Section 3.1. Operation of the catalytic incinerators is discussed in Section 3.2. Section 3.3 presents the instrumentation used to monitor and control the incinerators.

3.1 PRINTING OPERATION

The offset printing lines exhausting to the two tested incinerators at Plant C-3 operate similarly. The paper web, traveling at linear speeds up to 430 m/sec (1400 ft/sec) is imprinted with inks at several individual color stations. The ink applied in the press consists of colored pigments borne in a heavy organic solvent consisting of C_{12} through C_{18} organics with an average molecular weight of about 210 g/g-mole.

After all inks are applied, the final printed web passes through a direct natural gas-fired drying oven, in which the solvent is evaporated. The dried paper web leaves the oven for final cutting and folding. The vaporized solvent is pulled from the oven with the oven exhaust gas to a catalytic incinerator for VOC control.

3.2 CATALYTIC INCINERATOR OPERATION

The catalytic incinerators on printing lines 20 and 21 were designed and manufactured by TEC Systems. The incinerators are typically operated continuously, i.e., 24 hours per day for seven days per week, although the printing presses exhausting to the incinerators are characterized by frequent shutdowns and startups for job changes, web breaks, and miscellaneous maintenance. Both incinerators utilize heat recovery to minimize auxiliary fuel requirements. The incinerators are described in the following subsections.

3.2.1 Catalytic Incinerator 20

Catalytic incinerator 20, which is shown in Figure 3-1, was started up in February 1980. The incinerator is sized to handle 1.2 Nm^3/sec (2500 scfm) of solvent-laden air (SLA), which is delivered by a single blower. The SLA is preheated by an integral heat exchanger, which extracts heat from the incinerator exhaust gas, and then passes to the burner zone of the incinerator. The SLA is further heated by the combustion of natural gas and then enters a catalyst bed where solvents in the SLA are oxidized. The catalyst bed temperature is normally maintained at an average of 371°C (700°F). This temperature is measured as the average of the catalyst chamber inlet and outlet temperatures and is controlled by a fuel gas flow controller. The combustion products are then cooled in the SLA preheater and exhausted to the atmosphere.

The catalyst in incinerator 20 was replaced in September 1981. The catalyst consists of alumina-based pellets coated with oxides of copper, manganese, and trace amounts of palladium. The catalyst is arranged in modules with dimensions of 61 cm x 61 cm x 5 cm (24 in. x 24 in. x 2 in.). A total of 16 modules are in the catalyst chamber, yielding a total catalyst volume of 0.302 m^3 (10.7 ft^3). The design gas-phase residence time in the catalyst bed is 0.047 second, assuming a void fraction within the bed of 0.4. The destruction efficiency guaranteed by the vendor was 90 percent.

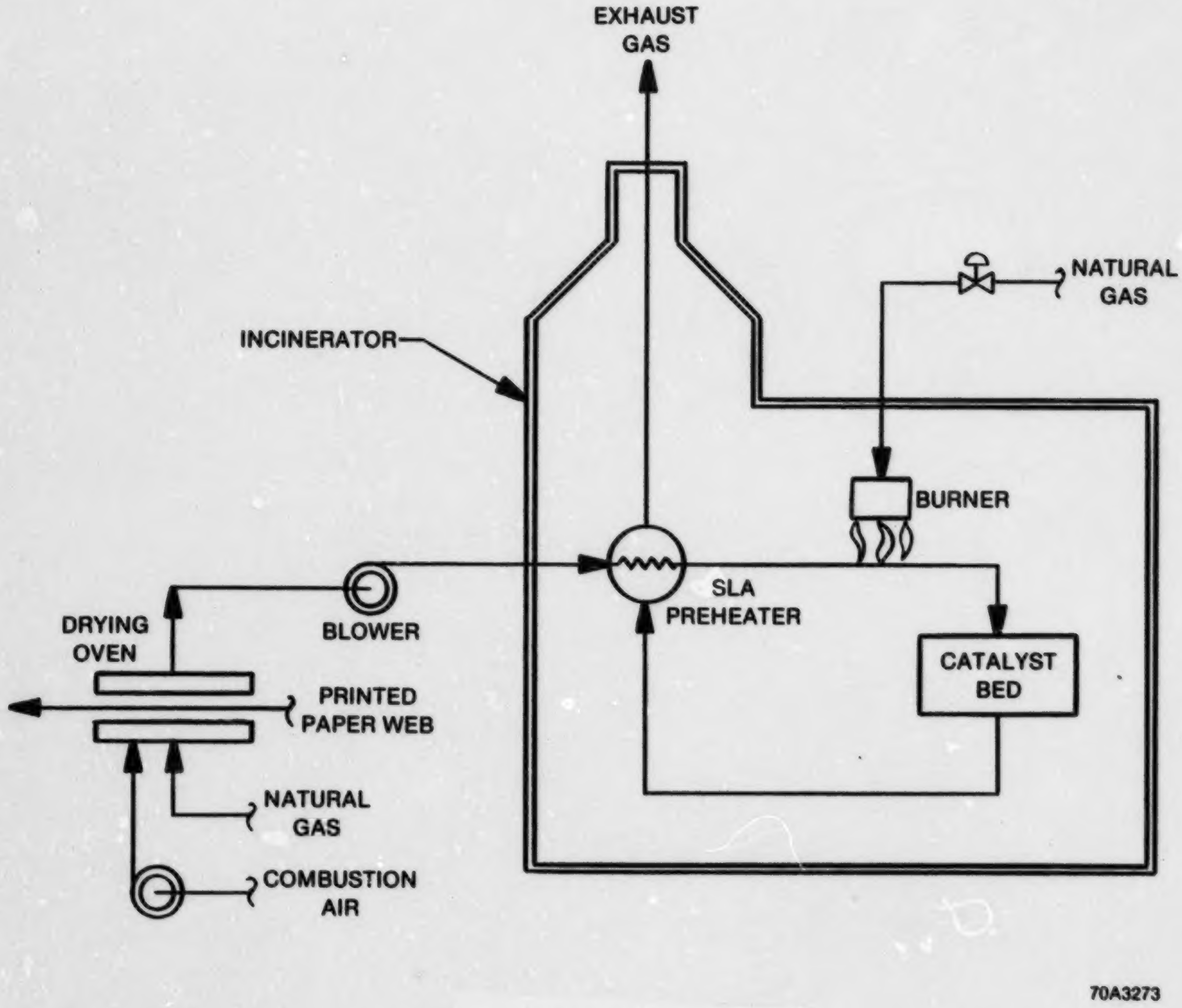
EXHAUST GAS
INCINERATOR
NATURAL GAS
BURNER
SLA PREHEATER
CATALYST BED
DRYING OVEN
BLOWER
PRINTED PAPER WEB
NATURAL GAS
COMBUSTION AIR
70A3273

Figure 3-1. Process Flow Diagram--Plant C-3 Catalytic Incinerator 20

3.2.2 Catalytic Incinerator 21

Catalytic incinerator 21, which was started up in April 1982, is shown in Figure 3-2. It features a relatively complex flow arrangement with two levels of heat recovery for maximum energy efficiency of the drying oven/incinerator system.

Pressroom air is drawn into the system by a blower and is preheated in a heat exchanger which extracts heat from the incinerator exhaust gas. The heated air enters the two gas-fired drying ovens (press 21 has dual printing lines) and evaporates solvent on the printed web. The SLA, at a rated flow of 2.0 Nm^3/sec (4300 scfm), is then further heated in a second heat exchanger and by the combustion of natural gas in the burner zone upstream of the catalyst chamber. The catalyst oxidizes remaining VOC's at an average temperature of 371°C (700°F), which is maintained by a natural gas flow controller. The incinerator exhaust gas then exits the catalyst chamber, is cooled in the two heat exchangers mentioned above, and is discharged to the atmosphere.

The catalyst in the incinerator during the January 1983 test program had been in service since startup nine months previously. The catalyst and module configurations are similar to those of incinerator 20. However, incinerator 21 contains 26 modules with a total catalyst volume of 0.491 m^3(17.3 ft^3). The design gas-phase residence time in the catalyst bed is 0.44 second, again assuming a 0.4 void fraction within the bed. The destruction efficiency guaranteed by the vendor was 90 percent.

3.3 INSTRUMENTATION AND CONTROLS

The catalytic incinerators on printing lines 20 and 21 at Plant C-3 are instrumented so that operation of the incinerators is fully automatic after system startup. The following instrumentation and controls are installed on the incinerators:

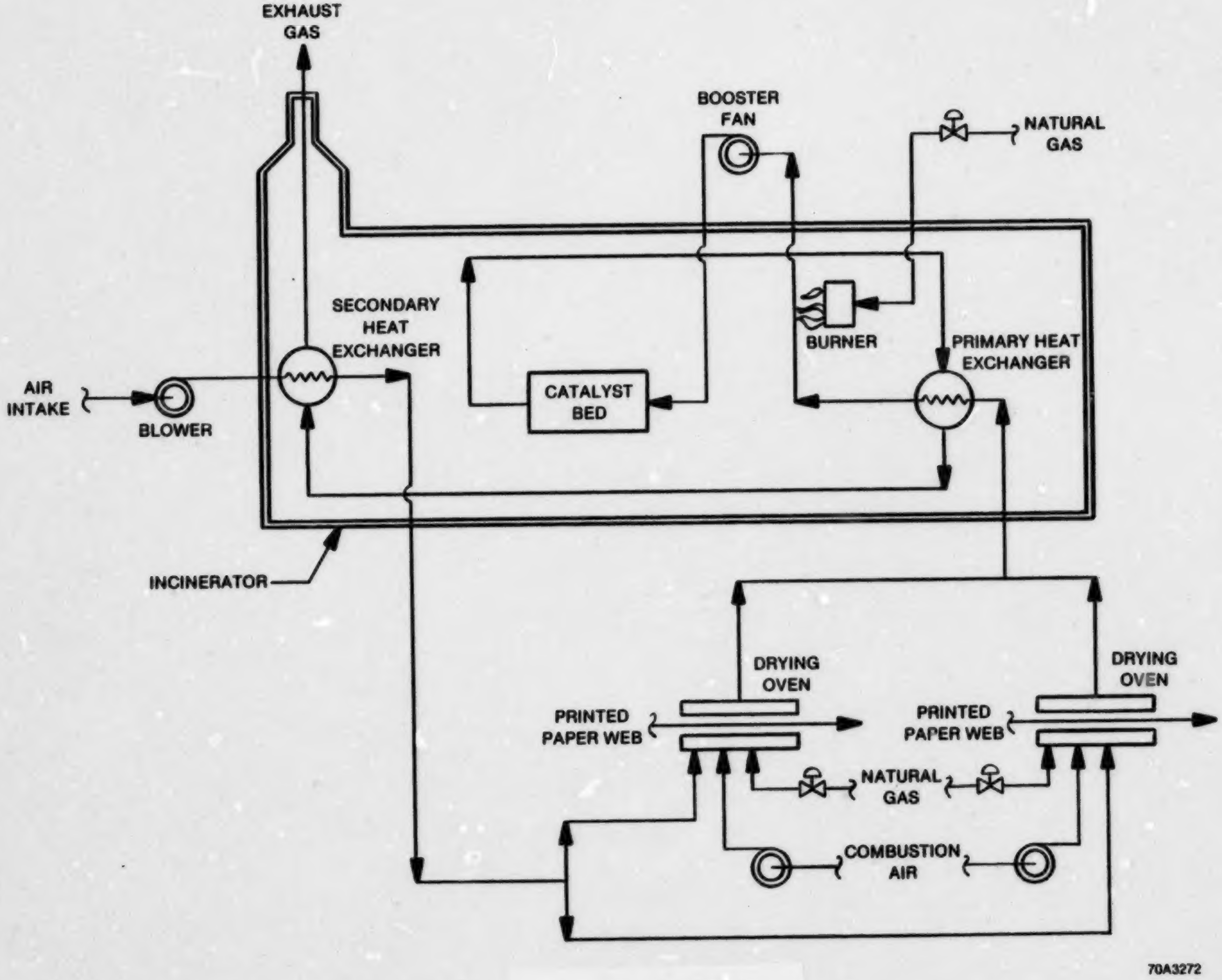
EXHAUST GAS
BOOSTER FAN
NATURAL GAS
SECONDARY HEAT EXCHANGER
BURNER
PRIMARY HEAT EXCHANGER
AIR INTAKE
BLOWER
CATALYST BED
INCINERATOR
DRYING OVEN
PRINTED PAPER WEB
DRYING OVEN
PRINTED PAPER WEB
NATURAL GAS
COMBUSTION AIR
70A3272

Figure 3-2. Process Flow Diagram--Plant C-3 Catalytic Incinerator 21

- a digital readout indicating catalyst inlet, outlet, and average temperature;
- fuel gas flow totalizers (the totalizer on incinerator 20 was not operational during the test period); and
- control panel lights indicating when blowers are operating.

In addition, the incinerators are designed to automatically shut down, i.e., fuel gas flow is stopped, in the event of (1) blower failure, (2) catalyst inlet temperature excursions below 288°C (550°F) or above 427°C (800°F), or (3) catalyst outlet temperature excursions above 538°C (1000°F).

SECTION 4

TEST METHODS

The primary objective of the test program conducted at Plant C-3 was to characterize the performance of the catalytic incinerators as a function of operating parameters. Specific sampling and analytical procedures used to gather performance data in support of the objective are introduced in this section. A detailed discussion of the test methods is presented in Appendix A.

The sampling and analytical procedures selected or developed to fulfill the program objective are summarized in Table 4-1; sampling locations are shown in Figures 4-1 and 4-2. These test methods and locations were used to perform the following analyses:

- VOC analysis,
- CO analysis,
- flow measurement, and
- other process measurements.

These analyses are discussed in the following sections.

4.1 VOC ANALYSIS

For the purposes of this program, incinerator inlet and outlet hydrocarbon concentrations are expressed on a parts-per-million-carbon (ppmc), or C_1, basis. By this method, the molar concentration of any hydrocarbon is multiplied by the number of carbon atoms in that hydrocarbon to yield the ppmc concentration, as shown below:

TABLE 4-1. SAMPLING AND ANALYTICAL PROCEDURES

Measurement Parameter	Sampling Location	Sampling Procedure	Analytical Procedure	Reference
Hydrocarbon Concentration (THC)	Inlet/Outlet	Rake-type probe, heated sampling line	FID-based THC analyzers	EPA Proposed Reference Method 25A
Hydrocarbon Concentration (Speciated)	Inlet/Outlet	Rake-type probe, heated sampling line	FID-based gas chromatograph	EPA Draft Reference Method 18
Hydrocarbon Species Identification	Inlet/Outlet	Rake-type probe, heated sampling line; evacuated canisters for light organics, impinger condensate for heavy organics	GC/MS	--
CO Concentration	Outlet	Rake-type probe, heated sampling line	FID-based analyzer with species separation and oxidation/reduction to methane	--
Molecular Weight (Fixed Gases)	Inlet/Outlet	Rake-type probe, heated sampling line	TCD-based analyzer	EPA Reference Method 3 (Equivalent)
Moisture Content	Inlet/Outlet	Goose-neck probe, chilled impinger train	Gravimetric determination of condensate, measurement of sampled gas volume	EPA Reference Method 4
Velocity/Volumetric Flow Rate	Outlet	S-type pitot tube	Calculations based on velocity pressure, temperature	EPA Reference Methods 1 and 2
Temperature	See Figure 4-1	K-type thermocouple	--	--
Pressure	See Figure 4-1	Magnehelic® gauge	--	--
Process Data	Various	Plant instrumentation	--	--

THC = total hydrocarbon
FID = flame ionization detector
GC/MS = gas chromatography/mass spectrometry
CO = carbon monoxide
TCD = thermal conductivity detector

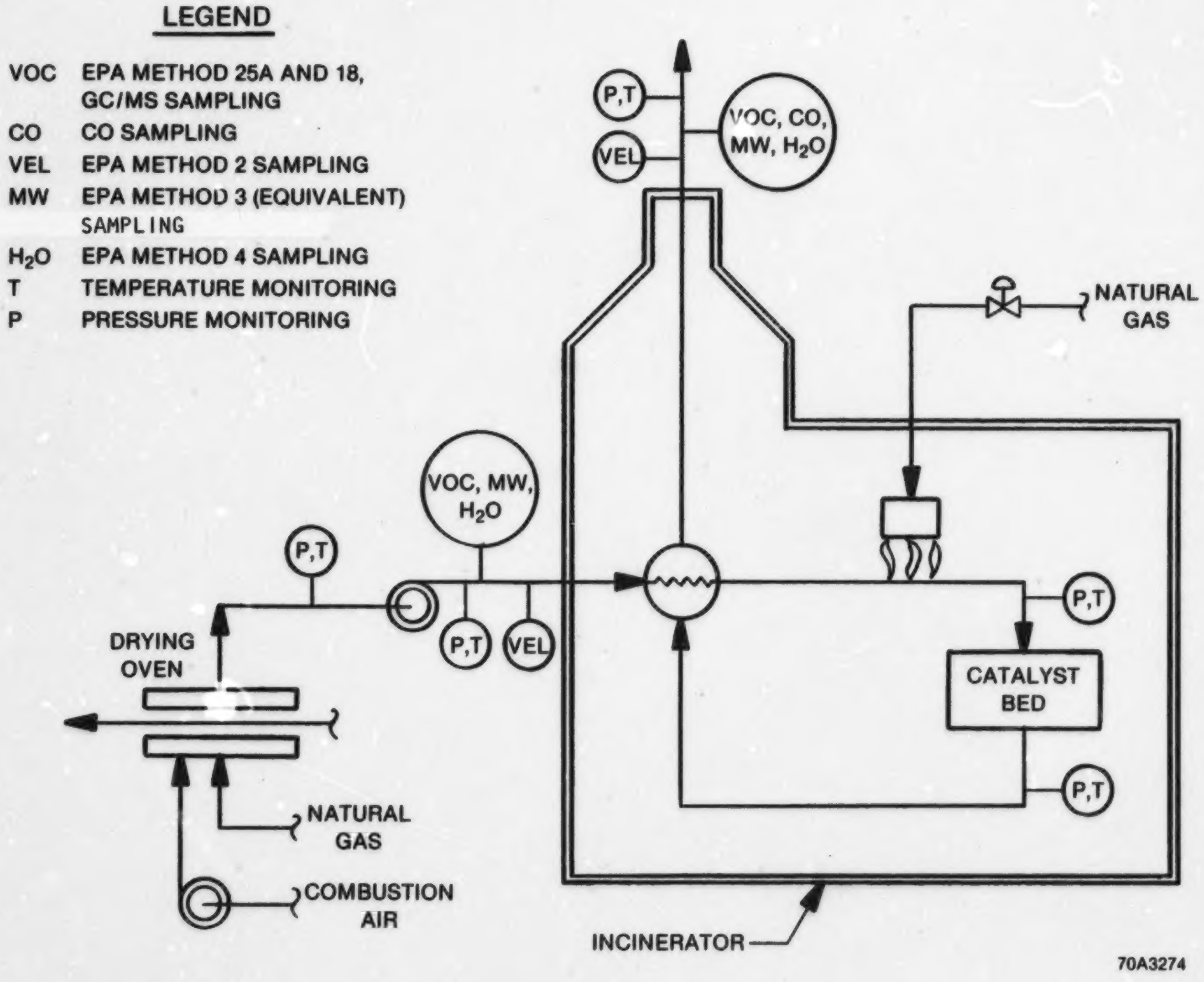
LEGEND
VOC EPA METHOD 25A AND 18, GC/MS SAMPLING
CO CO SAMPLING
VEL EPA METHOD 2 SAMPLING
MW EPA METHOD 3 (EQUIVALENT) SAMPLING
H_2O EPA METHOD 4 SAMPLING
T TEMPERATURE MONITORING
P PRESSURE MONITORING
P,T
VEL
VOC, CO, MW, H_2O
NATURAL GAS
VOC, MW, H_2O
P,T
DRYING OVEN
P,T
VEL
P,T
CATALYST BED
P,T
NATURAL GAS
COMBUSTION AIR
INCINERATOR
70A3274

Figure 4-1. Sampling Locations--Incinerator 20

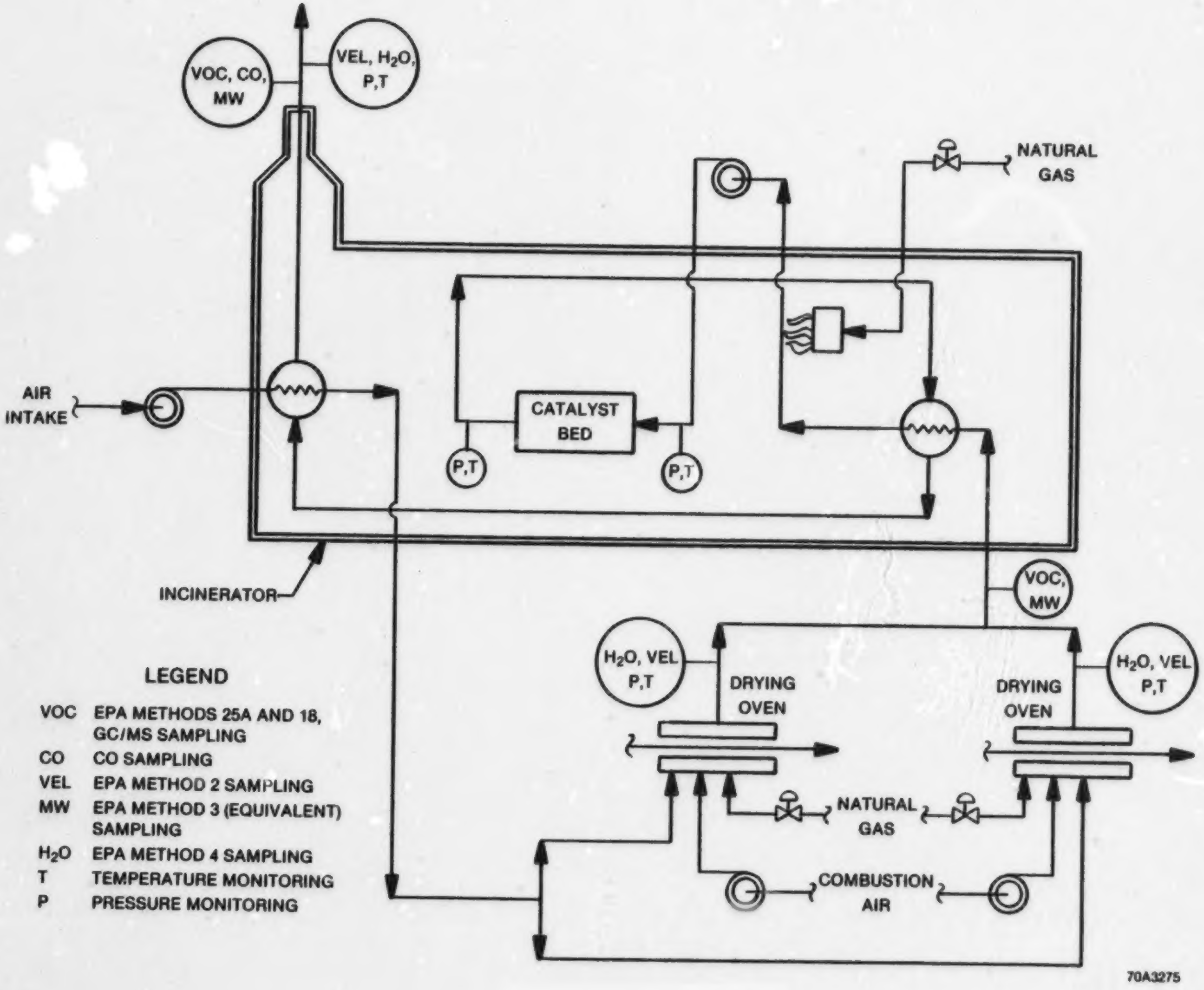
VOC, CO, MW
VEL, H_2O, P,T
NATURAL GAS
AIR INTAKE
CATALYST BED
P,T
P,T
INCINERATOR
VOC, MW
H_2O, VEL P,T
DRYING OVEN
H_2O, VEL P,T
DRYING OVEN
NATURAL GAS
COMBUSTION AIR
LEGEND
VOC EPA METHODS 25A AND 18, GC/MS SAMPLING
CO CO SAMPLING
VEL EPA METHOD 2 SAMPLING
MW EPA METHOD 3 (EQUIVALENT) SAMPLING
H_2O EPA METHOD 4 SAMPLING
T TEMPERATURE MONITORING
P PRESSURE MONITORING
70A3275

Figure 4-2. Sampling Locations--Incinerator 21

Compound	Concentration, ppmv	C_1 Concentration, ppmc
Methane (C_1)	1000	1000
Methanol (C_1)	1000	1000
Ethane (C_2)	1000	2000
Propane (C_3)	1000	3000
Hexane (C_6)	1000	6000
Benzene (C_6)	1000	6000
Pentadecane (C_{15})	1000	15000

The Method 25A and 18 analyzers used throughout this program were calibrated with propane (C_3) standards, since it was not practical to develop compound-specific hydrocarbon standards for each incinerator tested. Although propane standards are commonly used for instrument calibration, it is necessary to realize that the response of FID based hydrocarbon analyzers is a function of hydrocarbon type. Therefore, the measured concentration, relative to propane, may be somewhat different than the actual concentration.

The above measurement basis was applied to the two primary VOC analytical procedures used in this program:

- total hydrocarbon (THC) analysis and
- VOC measurement and speciation by gas chromatography (GC).

These methods were used to quantify hydrocarbon concentrations in the incinerator inlet and outlet gas streams. In addition, gas chromatography/mass spectrometry (GC/MS) analyses were performed to positively identify as many species as possible in the inlet and outlet streams.

THC Analysis

EPA Proposed Reference Method 25A (4-2) was used to sample and analyze for THC concentrations in the inlet and outlet gas streams. A stainless steel rake-type sampling probe and heated sampling lines were used to deliver gas samples to the analytical system, as shown in Figure 4-3.

THC analysis involves introduction of a gas sample directly to a flame ionization detector (FID) where any organics in the gas sample are burned. The resulting ionized combustion products establish an electrical current in the presence of oppositely charged electrodes. The strength of the current is directly proportional to the total amount (concentration) of organics present in the sample; therefore, the detector current output from a calibrated THC analyzer can be expressed as a total organic concentration. However, no information is generated with regard to identification or quantification of individual organic compounds.

A Tracor Model 560 GC, operated with the gas sample introduced directly to the FID, and a Byron 401 THC analyzer were used to measure THC concentrations of the incinerator inlet and outlet gas streams, respectively, providing data at four- and one-minute intervals. The Byron analyzer output data were automatically monitored and stored by an electronic data acquisition system.

GC Analysis

Inlet and outlet hydrocarbon concentrations were also measured by an onsite FID-based GC, as specified in EPA Draft Reference Method 18 (4-3) and as shown earlier in Figure 4-3.

Hydrocarbon analysis by gas chromatography features the separation of gas-phase organics into specific compounds or groups of compounds prior to their measurement by the FID. This separation is accomplished by first passing the gas sample through an adsorption column. The length of time required for the compounds or groups of compounds to pass through the column is a function of certain physical and chemical properties, e.g., molecular weight. The FID measures the concentration of each compound or group of compounds as it elutes from the column. Prior knowledge of the composition

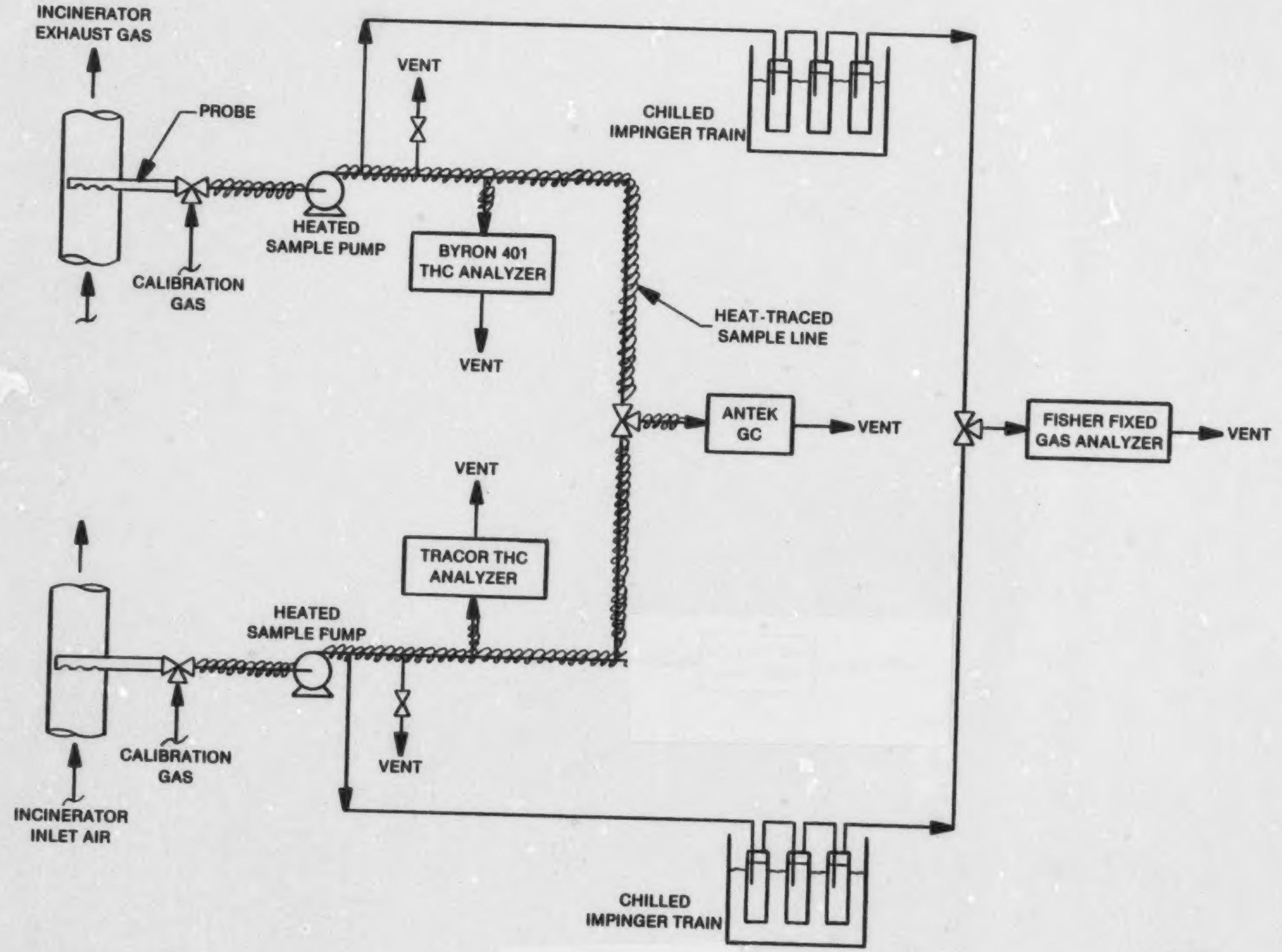
INCINERATOR EXHAUST GAS
PROBE
CALIBRATION GAS
HEATED SAMPLE PUMP
VENT
BYRON 401 THC ANALYZER
VENT
CHILLED IMPINGER TRAIN
HEAT-TRACED SAMPLE LINE
ANTEK GC
VENT
FISHER FIXED GAS ANALYZER
VENT
VENT
TRACOR THC ANALYZER
HEATED SAMPLE FUMP
CALIBRATION GAS
VENT
INCINERATOR INLET AIR
CHILLED IMPINGER TRAIN
70A3271

Figure 4-3. Sampling and Analytical System--Plant C-3

of the gas sample being analyzed and the use of calibration standards to determine retention times of known organic compounds can allow both identification and quantification of a particular eluting peak.

An Antek Model 460 GC was used to speciate the incinerator inlet and outlet gas streams. A specific column and temperature program were selected for this site to allow both speciation and quantification of the hydrocarbons. The GC was operated on an intermittent basis, requiring a total cycle time of 20 to 30 minutes for a single analysis.

GC/MS Analysis

Positive identification of organic species in selected samples was accomplished by GC/MS analysis in Radian's Austin laboratories. Samples included gas samples collected in evacuated metal canisters and condensate samples reserved from the moisture content analyses.

GC/MS provides a qualitative determination of organic constituents in a process stream. The major constituents are identified, as well as their relative concentrations. The analysis provides additional information on the destruction efficiency of individual organics and on the potential formation of new organics.

4.2 CO ANALYSIS

CO concentrations of the incinerator exhaust gas were periodically measured by the Byron 401 THC Analyzer operating in the "Full Scan" (FS) mode. In this mode, a gas sample is introduced directly to the FID, yielding a THC measurement. Subsequently, a second sample is injected and nonmethane hydrocarbons (NMHC), CH_4, CO_2, and CO are chromatographically separated. One at a time, each of these groups is passed through an oxidizer/reducer to convert all carbon to CH_4. These reduced streams are then individually introduced to the FID for measurement, with a complete cycle requiring 12 minutes.

4.3 FLOW MEASUREMENT

Measurement of the incinerator process gas flow rates was performed using EPA Reference Methods 1, 2, 3 (equivalent), and 4 (4-4, 4-5, 4-6, and 4-7). By these methods, gas velocity is calculated using (1) the average gas temperature and velocity pressure as determined by a pitot tube traverse of the duct, (2) the wet molecular weight, and (3) the static pressure of the gas. A Fisher Model 1200 Gas Partitioner was used to measure fixed gas (CO_2, O_2, and N_2) concentrations using a procedure equivalent to the EPA Method 3 determination of dry molecular weight.

The incinerator inlet air and outlet gas flow rates were combined with their corresponding VOC concentration data to yield inlet and outlet VOC mass rates and the VOC destruction efficiency.

4.4 PROCESS MEASUREMENTS

Continuous temperature recorders were used to monitor various process temperatures, as shown previously in Figure 4-1. Magnehelic® gauges and inclined manometers were used to measure pressures. In addition, plant instrumentation and data were used to monitor certain additional process parameters, e.g., web speed.

4.5 REFERENCES

4-1 Characterization of VOC Emissions from Catalytic Incinerators, Test Plan for Plant C-3 (Confidential). EPA Contract No 68-02-3171. Radian Corporation. January 11, 1983.

4-2 EPA Proposed Method 25A, "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer." Proposed Revision to Appendix A 40 CFR, Federal Register, Volume 45, Number 194. December 17, 1980. pp. 83149-83151.

4-3 EPA Draft Method 18, "Measurement of Gaseous Organic Compound Emissions by Gas Chromatography." Personal communication with Jeff Chappell, U.S. Environmental Protection Agency, IERL-RTP.

4-4 EPA Reference Method 1, "Sample and Velocity Traverses for Stationary Sources." Appendix A to 40 CFR, Environment Reporter. Bureau of National Affairs. Washington, D.C. December 5, 1980. pp. 23-25.

4-5 EPA Reference Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)." Appendix A to 40 CFR, Environment Reporter. Bureau of National Affairs. Washington, D.C. December 5, 1980. pp. 25-33.

4-6 EPA Reference Method 3, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight." Appendix A to 40 CFR, Environment Reporter. Bureau of National Affairs. Washington, D.C. December 5, 1980. pp. 33-36.

4-7 EPA Reference Method 4, "Determination of Moisture Concent in Stack Gases." Appendix A to 40 CFR, Environment Reporter. Bureau of National Affairs. Washington, D.C. December 5, 1980. pp. 36-41.

203-001-50-06

SECTION 5

RESULTS OF TESTING AND ANALYSIS

Performance testing of the two catalytic incinerators at Plant C-3 was conducted from January 17 through January 28, 1983. Testing focused on characterization of the incinerators' (1) operating parameters, such as SLA flow rate, system temperatures, and system pressures; (2) hydrocarbon destruction performance; and (3) CO generation. The results of this testing are presented in Sections 5.1, 5.2, and 5.3, respectively. Conclusions drawn from the test results are presented in Section 5.4.

5.1 OPERATING PARAMETERS

The operating parameters of the catalytic incinerators at Plant C-3 are discussed in this subsection. The discussion focuses on the data summarized in Tables 5-1 and 5-2 for incinerators 20 and 21, respectively.

5.1.1 Incinerator 20

The information in Table 5-1 represents performance data gathered with both the press and the incinerator operating at relatively steady-state conditions, which occurred approximately 67 percent of the time during the test period (see Appendix C). The table does not include operating data for the incinerator with the press off or running at slow speeds during startup.

The performance data in Table 5-1 are categorized by catalyst temperature setpoint. Three tests were defined that correspond to temperature setpoints of 371°C, 385°C, and 399°C. These three tests encompassed a 68-hour period. During this period, a single printing job was run, resulting in

TABLE 5-1. SUMMARY OF OPERATING PARAMETERS FOR INCINERATOR 20

Parameters	Test 1 371°C (700°F) Setpoint	Test 2 385°C (725°F) Setpoint	Test 3 399°C (750°F) Setpoint
Flows:			
Inlet SLA flow rate	1.26 Nm^3/sec (2660 scfm, wet)	1.27 Nm^3/sec (2680 scfm, wet)	1.23 Nm^3/sec (2600 scfm, wet)
Natural gas flow rate[a]	0.0052 Nm^3/sec (11 scfm)	0.0057 Nm^3/sec (12 scfm)	0.0061 Nm^3/sec (13 scfm)
Natural gas energy usage[b]	730×10^6 J/hr (690,000 Btu/hr)	790×10^6 J/hr (750,000 Btu/hr)	850×10^6 J/hr (810,000 Btu/hr)
Exhaust gas flow rate[c]	1.26 Nm^3/sec (2670 scfm, wet)	1.27 Nm^3/sec (2690 scfm, wet)	1.23 Nm^3/sec (2610 scfm, wet)
Stack gas velocity	17.2 m/sec (56.3 ft/sec)	17.8 m/sec (58.3 ft/sec)	17.5 m/sec (57.3 ft/sec)
SLA residence time	0.043 sec	0.042 sec	0.042 sec
Temperatures:			
Inlet SLA	177°C (350°F)	179°C (355°F)	177°C (350°F)
Catalyst inlet/outlet	327°C/379°C (701°F/713°F)	385°C/394°C (725°F/741°F)	399°C/409°C (751°F/769°F)
Catalyst ΔT	7°C (12°F)	9°C (16°F)	10°C (18°F)
Stack gas	307°C (585°F)	324°C (615°F)	332°C (630°F)
Pressures:[d]			
Inlet SLA (blower Suction)	100.8 kPa (-2.4 in. H_2O)	100.8 kPa (-2.4 in. H_2O)	100.8 kPa (-2.4 in. H_2O)
Inlet SLA (blower discharge)	102.5 kPa (4.6 in. H_2O)	102.5 kPa (4.6 in. H_2O)	102.5 kPa (4.6 in. H_2O)
Catalyst inlet/outlet	101.9/101.6 kPa (2.0/1.0 in.H_2O)	101.9/101.6 kPa (2.0/1.0 in.H_2O)	101.9/101.6 kPa (2.0/1.0 in. H_2O)
Catalyst ΔP	0.3 kPa (1.0 in. H_2O)	0.3 kPa (1.0 in. H_2O)	0.3 kPa (1.0 in. H_2O)
Stack gas	101.4 kPa (0.3 in H_2O)	101.4 kPa (0.3 in. H_2O)	101.4 kPa (0.3 in. H_2O)
Energy Recovery[e]	36%	34%	35%
Blower Power[d]	25.4 kW (34.0 HP)	25.4 kW (34.0 HP)	25.4 kW (34.0 HP)

[a] Estimated from an energy balance (see Appendix L).

[b] Based on local natural gas higher heating value of 38,700 KJ/Nm^3 (1040 Btu/scf).

[c] Inlet SLA plus natural gas.

[d] Measured at one condition (Test 1).

[e] $\frac{\text{Heat added to inlet SLA by preheater}}{\text{Heat necessary to raise inlet SLA to catalyst inlet temperature}} \times 100\%$ (See Appendix L).

TABLE 5-2. SUMMARY OF OPERATING PARAMETERS FOR INCINERATOR 21

Parameters	Test 1 371°C (700°F) Setpoint	Test 2 385°C (725°F) Setpoint	Test 3 399°C (750°F) Setpoint
Flows:			
Inlet SLA flow rate	2.21 Nm^3/sec (4670 scfm, wet)	2.17 Nm^3/sec (4600 scfm, wet)	2.14 Nm^3/sec (4530 scfm, wet)
Natural gas flow rate[a]	0.0043 Nm^3/sec (9 scfm)	0.0061 Nm^3/sec (13 scfm)	0.0061 Nm^3/sec (13 scfm)
Natural gas energy usage[b]	620 x 10^6 J/hr (590,000 Btu/hr)	830 x 10^6 J/hr (790,000 Btu/hr)	830 x 10^6 J/hr (790,000 Btu/hr)
Exhaust gas flow rate[c]	2.21 Nm^3/sec (4680 scfm, wet)	2.18 Nm^3/sec (4610 scfm, wet)	2.14 Nm^3/sec (4540 scfm, wet)
Stack gas velocity	11.9 m/sec (38.9 ft/sec)	11.6 m/sec (38.2 ft/sec)	11.3 m/sec (37.2 ft/sec)
SLA residence time	0.040 sec	0.040 sec	0.039 sec
Temperatures:			
Inlet SLA	178°C (352°F)	182°C (359°F)	177°C (351°F)
Catalyst inlet/outlet	358°C/412°C (677°F/774°F)	381°C/409°C (717°F/768°F)	391°C/432°C (736°F/810°F)
Catalyst ΔT	54°C (97°F)	28°C (51°F)	41°C (74°F)
Stack gas	244°C (472°F)	243°C (469°F)	237°C (459°F)
Pressures:			
Inlet SLA (drying oven discharge)	100.8 kPa (-2.2 in. H_2O)	100.8 kPa (-2.1 in. H_2O)	100.9 kPa (-2.0 in. H_2O)
Catalyst ΔP	0.3 kPa (1.0 in. H_2O)	0.3 kPa (1.0 in. H_2O)	0.3 kPa (1.0 in. H_2O)
Stack Gas	101.3 kPa (-0.26 in. H_2O)	101.3 kPa (-0.20 in. H_2O)	101.3 kPa (-0.20 in. H_2O)
Energy Recovery[d]	66%	58%	61%
Blower Power[e]	1.4 kW (1.9 HP)	1.4 kW (1.9 HP)	1.4 kW (1.9 HP)
Booster Fan Power[e]	15.4 kW (20.6 HP)	15.4 kW (20.6 HP)	15.4 kW (20.6 HP)

[a] Estimated from an energy balance (see Appendix L).

[b] Based on local natural gas higher heating value of 38,700 KJ/Nm^3 (1040 Btu/scf).

[c] Inlet SLA plus natural gas.

[d] $$\frac{\text{Heat added to SLA by primary heat exchanger}}{\text{Heat necessary to raise inlet SLA to catalyst inlet temperature}} \times 100\%$$ (see Appendix L).

[e] Measured by plant personnel after the test program was complete.

essentially identical press operating conditions with regard to ink application rate and ink composition for all three tests.

The flow rate of SLA from the press drying oven to the incinerator was relatively constant for all three tests, measuring from 1.2 to 1.3 Nm^3/sec (2600 to 2700 scfm). Natural gas consumption increased as the catalyst temperature setpoint was adjusted higher, but natural gas flow was negligible compared to the SLA flow. Thus the exhaust gas flows were essentially equal to inlet SLA flows. At the elevated catalyst chamber temperatures, gas residence time in the catalyst bed approximated 0.042 seconds for all three tests.

As would be expected for steady press operation, the temperature of the inlet SLA to the incinerator system (upstream of the SLA preheater) was constant for the three tests, averaging about 177°C (350°F). However, the catalyst inlet and outlet temperatures were generally higher with increasing temperature setpoint because of the higher fuel gas flows, as shown in the table. The temperature rise across the bed increased through the three tests. However, each test was characterized by increasingly higher average inlet THC concentrations (as discussed in Section 5.2). The higher the inlet THC loading, the greater the oxidation heat release which causes a higher temperature rise across the catalyst bed. The fact that the temperature rise was relatively low at 7°C to 10°C (12°F to 18°F) suggests that THC destruction was not complete, perhaps because of some degree of deactivation of the catalyst. However, the relatively low pressure drop of 0.3 kPa (1.0 in. H_2O) measured across the catalyst does not suggest severe fouling.

Finally, the use of the SLA preheater (see Figure 3-1) resulted in significant fuel gas savings, as shown by the "energy recovery" values averaging 35%. This value refers to the percentage of heat provided by the SLA preheater of the total required to raise the SLA from the system inlet temperature (nominally 177°C) to the catalyst inlet temperature (nominally 371°C).

5.1.2 Incinerator 21

Testing of incinerator 21 was conducted in a manner similar to that of incinerator 20. Tests were conducted at three catalyst temperature setpoints (371°C, 385°C, and 399°C), as shown in Table 5-2. As with the data presented earlier, Table 5-2 presents only data characterizing incinerator performance with the press/incinerator system operating at steady-state conditions, which accounted for approximately 63 percent of the total test period. However, in contrast to the incinerator 20 test period in which only one printing job was run, the 55-hour incinerator 21 test period encompassed five different printing jobs. As a result, system conditions were more variable, particularly press speed and coating application rate. The effects of these variable conditions on incinerator operating parameters are discussed in this subsection; their effects on VOC destruction performance are analyzed further in Section 5.2.

The performance data in Table 5-2 indicate that inlet SLA flow rate was relatively constant for all three tests, ranging from 2.1 to 2.2 Nm^3/sec (4500 to 4700 scfm). Fuel gas flow was negligible compared to the inlet SLA flow. The fuel gas flow during Test 1 was considerably lower than for the other tests, because the average inlet THC concentration, as presented in Section 5.2, was considerably higher; i.e., the presence of a greater amount of VOC "fuel" allowed fuel gas consumption to be decreased (also, of course, the catalyst temperature setpoint was lower during Test 1). Although the catalyst temperature setpoint was higher during Test 3 than Test 2, fuel gas consumption was the same. This occurred because inlet VOC concentrations were higher during Test 3 than Test 2, so less fuel gas was needed to provide heat. In general, over the range of conditions tested, fuel gas consumption was affected more by the inlet THC concentration than any other parameter.

Temperature of the SLA from the drying ovens was approximately the same as for the previous incinerator, averaging about 180°C (356°C). However, the temperature rise across the catalyst bed was considerably higher for incinerator 21, as shown in the table. Average temperature increases ranged from 28°C to 54°C (51°F to 97°F), with the higher values associated with higher inlet VOC concentrations.

As shown in the table, energy recovery by the primary heat exchanger (see Figure 3-2) was significant, representing about 60 percent of the total energy required to raise the temperature of the SLA from the drying oven exhaust temperature to the catalyst inlet temperature. The secondary heat exchanger's energy contribution is not credited to the incinerator; rather, it is credited to the drying ovens.

5.2 HYDROCARBON DESTRUCTION PERFORMANCE

The results of the VOC analysis performed for the Plant C-3 incinerators are presented in this section. Total hydrocarbon (THC) data collected according to EPA Proposed Reference Method 25A are presented in Section 5.2.1. Gas chromatography (GC) data collected using EPA Draft Reference Method 18 are presented in Section 5.2.2. Finally, GC/mass spectrometry (MS) results are presented in Section 5.2.3.

5.2.1 EPA Proposed Reference Method 25A Results

Results of the THC analysis are presented in this subsection for each incinerator. Included in the discussion are the effects of operating variables on VOC destruction efficiency and emissions.

5.2.1.1 Incinerator 20

The results of the THC analysis conducted during the three tests of incinerator 20 are summarized in Table 5-3. The following factors appear to have affected the performance of the incinerator: (1) inlet THC concentration, (2) catalyst temperature setpoint, (3) nature of system operation--steady or unsteady, and (4) catalyst age.

TABLE 5-3. SUMMARIZED EPA METHOD 25A RESULTS--INCINERATOR 20

Test Number	Catalyst Temperature Setpoint, °C (°F)	Operating Conditions/Hours[a]	Product ID	Web Speed, m/sec (fpm)	Inlet THC Concentration (C_1), ppmc	Outlet THC Concentration (C_o), ppmc	Catalyst ΔT, °C (°F)	Destruction[c] Efficiency, %
1	371 (700)	Steady-state/5.5	A	6.65 (1310)	1240	241	7 (12)	80.1
		Unsteady-state/4.1		-[b]	280	98	-	65.0
		Total/9.6		-	830	180	-	78.3
2	385 (725)	Steady-state/6.7	A	6.60 (1300)	1530	248	9 (16)	83.8
		Unsteady-state/1.7		-	168	30	-	82.1
		Total/8.4		-	1250	204	-	83.7
3	399 (750)	Steady-state/3.0	A	7.11 (1400)	1690	227	10 (18)	86.6
		Unsteady-state/1.6		-	177	95	-	46.3
		Total/4.6		-	1160	181	-	84.4

[a] Does not include time periods in which (1) instruments were undergoing calibration, (2) the incinerator was shut down, or (3) instrument malfunctions invalidated the data.

[b] Value is highly variable and, therefore, not calculated or monitored.

[c] Destruction Efficiency = $\frac{M_{in} - M_{out}}{M_{in}} \times 100\%$, where

$$M = \text{THC mass rate} = \frac{(V)\ \text{moles C}}{10^6\ \text{moles gas}} \times \frac{12\ \text{gC}}{\text{mole C}} \times \frac{\text{mole gas}}{0.0237\ \text{m}^3\text{gas}} \times \frac{(Q)\ \text{m}^3\text{gas}}{\text{sec}}$$

V = THC concentration, ppmc (in or out)

Q = gas flow rate, Nm^3/sec (in or out)

Inlet THC Concentration--The inlet THC concentration is typically dependent on the printing operation, i.e., drying air flow rate and temperature, web speed, and percent of coverage (a measure of the amount of ink applied on the printed product). Since the three tests were conducted during a time period in which a single job was run (Product A), steady-state printing conditions should have been relatively constant. However, as shown in the table, average inlet THC concentrations ranged from 1240 to 1690 ppmc for the three tests. This variation is unexplained, although measured changed in web speed may partly account for it.

As average inlet THC concentration increased during the three tests, THC destruction efficiency increased from 80 to 87 percent during steady-state operation. Of course, the catalyst temperature setpoint was also increased. As a result, the single effect of either variable, inlet THC concentration or catalyst temperature setpoint, on THC destruction efficiency could not be determined from the summarized data. Therefore, steady-state THC data within each of the three tests were re-analyzed to determine the effect of inlet THC concentration and catalyst temperature setpoint on THC destruction efficiency. The results of this analysis are summarized in Figure 5-1.

Shown in the figure are THC destruction efficiencies calculated for all periods of steady-state operation at 50-ppmc intervals. For example, for time periods in which the inlet THC concentration was measured as 975±25 ppmc, the destruction efficiency averaged 74.3 percent at a catalyst temperature setpoint of 371°C (700°F); for time periods in which the inlet concentration measured 1675±25 ppmc, the destruction efficiency averaged 85.5 percent and 86.9 percent, respectively, for catalyst temperatures of 385°C and 399°C (725°F and 750°F).

This analysis clearly shows the effect of inlet THC concentration on destruction efficiency for a given catalyst temperature setpoint. In all three tests, indicated by the three linear curve fits in Figure 5-1, the THC

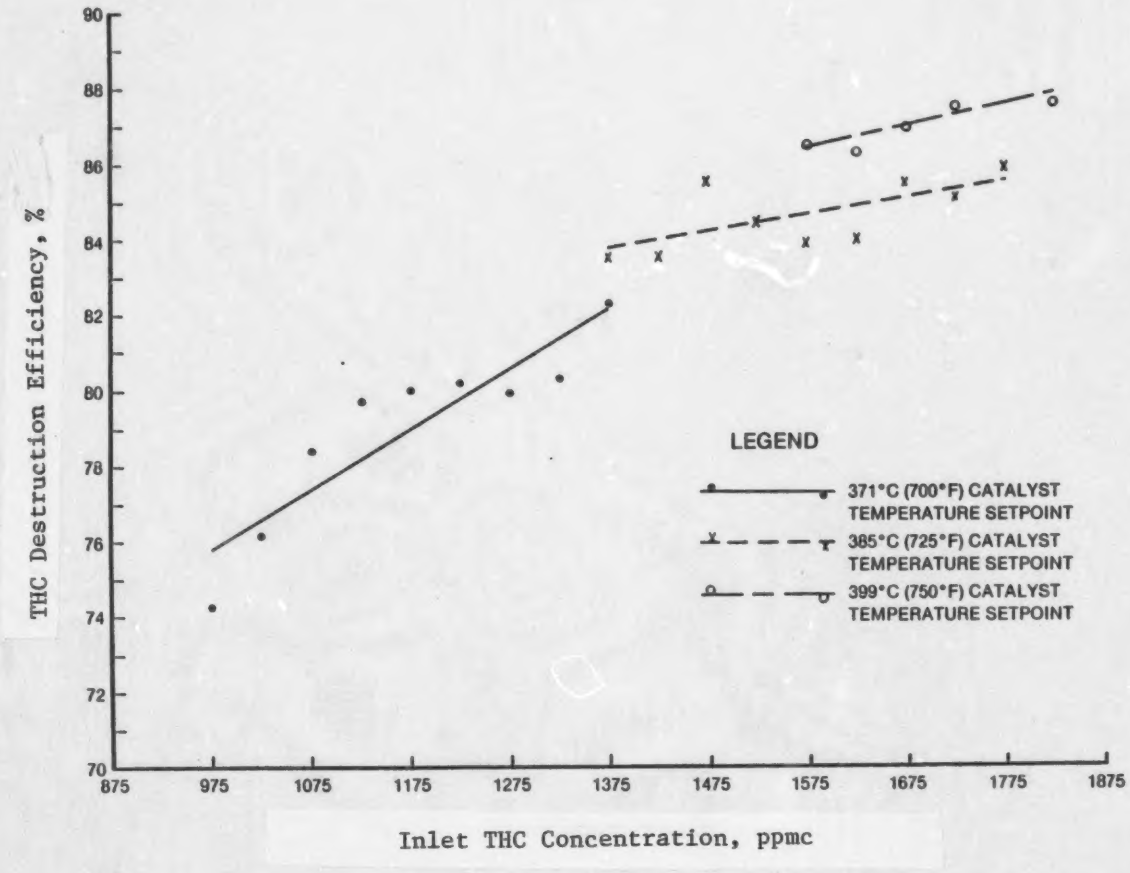

Figure 5-1. Effect of inlet THC concentration and catalyst temperature setpoint on THC destruction efficiency--Incinerator 20.

destruction efficiency increased with inlet THC concentration over the range of concentrations tested.

Catalyst Temperature Setpoint--Similarly, the simultaneous increase in inlet THC concentration and catalyst temperature setpoint as averaged over the three tests (Table 5-3) prevented the establishment of a correlation, based on these values, between catalyst temperature and THC destruction efficiency. However, the analysis described in the previous subsection and depicted in Figure 5-1 also indicates the effect of catalyst temperature setpoint on VOC destruction efficiency. The data support the expected trends, with destruction efficiency increasing with catalyst temperature setpoint for a given inlet THC concentration.

System Operation--THC analysis during steady-state press/incinerator operation yielded results that were consistent with the performance parameters, e.g., inlet THC concentration, temperature, and press speed. However, the transient nature of the operation categorized as unsteady resulted in highly variable average THC analysis results. For example, average THC destruction efficiency for the unsteady periods of the three tests ranged from 46 to 87 percent, with point-in-time values of even greater variation. These variations were due to random and dissimilar operating parameters and events, including those related to system temperatures, flow rates, and VOC evaporation rates.

In general, however, the incinerator's THC destruction performance during steady-state operation heavily weighted the total integrated incinerator performance (steady plus unsteady operation), resulting in time-averaged THC destruction efficiencies ranging from 78 to 87 percent, as shown in the table.

The effect of steady and unsteady press/incinerator operation on instantaneous THC concentrations and catalyst temperatures is graphically shown in Figure 5-2. The incinerator responded rapidly to changing printing process conditions, such as web breaks, as shown by the manner in which the outlet (2)

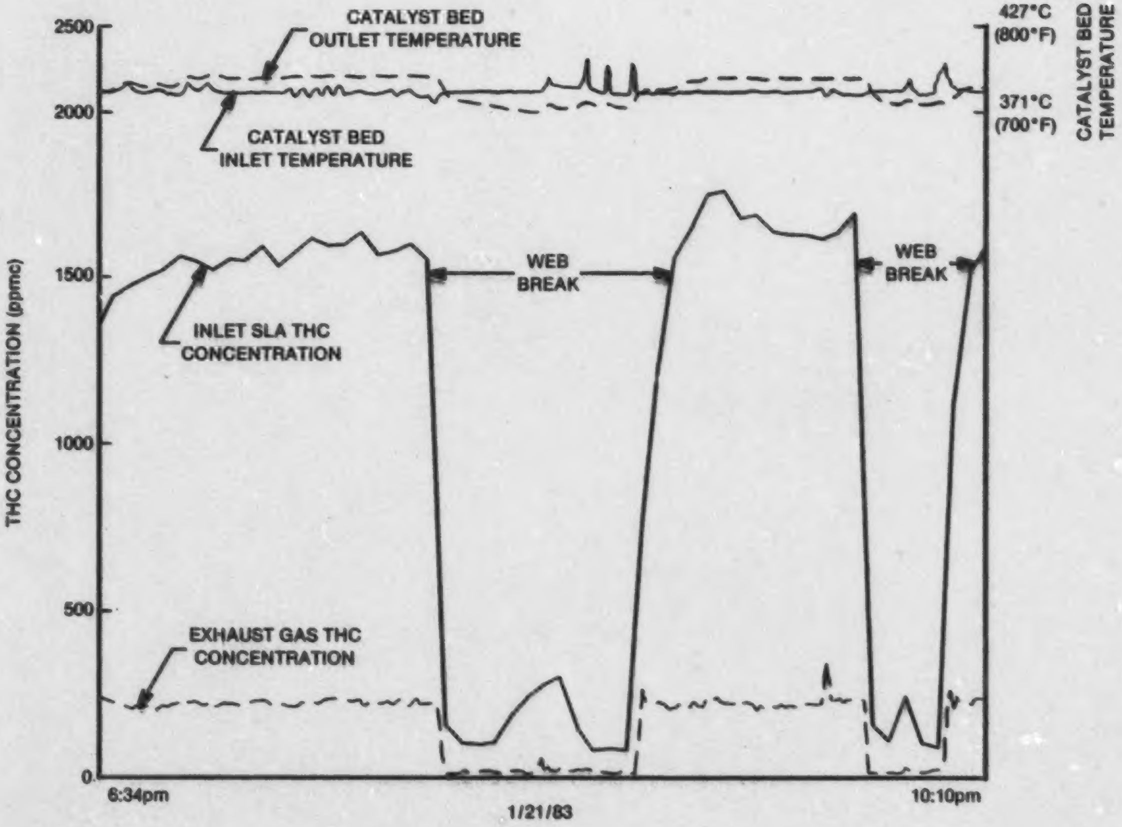

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Figure 5-2. Example THC and Catalyst Temperature Profiles--Incinerator 20

THC concentration and catalyst temperature profiles correspond to the inlet THC concentration profile in the figure.

Catalyst Age--The catalyst in incinerator 20 had been in service for 16 months when the testing occurred. The catalyst's 16-month service life may have contributed to the relatively low, i.e., less than 90 percent, THC destruction efficiency. This apparent correlation is supported by comparing the performance of incinerator 20 to that of incinerator 21, which contained a fresher catalyst charge and attained THC destruction efficiencies of 93 to 96 percent, as discussed in Section 5.2.1.2.

5.2.1.2 Incinerator 21

THC results for the three tests conducted for incinerator 21 are summarized in Table 5-4. The effects on performance of the following factors are discussed below: (1) inlet THC concentration, (2) catalyst temperature setpoint, (3) nature of system operation, and (4) catalyst age.

Inlet THC Concentration--Several different printing jobs were run on line 21 during the test program (Products B, C, D, E, and F), as shown in Table 5-4. As a result, inlet THC concentrations varied widely, averaging from 1370 to 4030 ppmc for steady-state incinerator operation. An analysis similar to that described in Section 5.2.1.1 was performed for incinerator 21 to discern the effect of inlet THC concentration on THC destruction efficiency. The results of this analysis are summarized in Figure 5-3. The figure shows that, over the wide range of inlet THC concentrations tested, inlet concentration had relatively little impact on THC destruction efficiency. Only at the lower end of the inlet concentration range did efficiency decrease slightly. The overall lack of significant correlation between inlet concentration and destruction efficiency was in contrast to the effect observed for incinerator 20.

Catalyst Temperature Setpoint--Figure 5-3 also indicates that, for incinerator 21, THC destruction efficiency increased with catalyst temperature

TABLE 5-4. SUMMARIZED EPA METHOD 25A RESULTS -- INCINERATOR 21

Test Number	Catalyst Temperature Setpoint, °C (°F)	Operating Conditions/Hours[a]	Product ID	Web Speed, m/sec (fpm)	Inlet THC Concentration (C_i), ppmc	Outlet THC Concentration (C_o), ppmc	Catalyst ΔT, °C (°F)	Destruction[c] Efficiency, %
1	371 (700)	Steady-state/5.5	B	5.74 (1130)	4030	165	63 (114)	95.9
		Unsteady-state/3.0		-[b]	807	55	-	93.2
		Total/8.5		-	2900	126	-	95.7
		Steady-state/1.7	C	5.59 (1100)	1370	90	22 (40)	93.4
		Unsteady-state/0.9		-	296	32	-	89.2
		Total/2.6		-	983	70	-	92.9
2	385 (725)	Steady-state/4.9	C	5.33 (1050)	1670	92	29 (53)	94.5
		Unsteady-state/0.9		-	136	27	-	80.0
		Total/5.8		-	1440	82	-	94.3
		Steady-state/5.4	D	6.10 (1200)	1910	100	28 (50)	94.7
		Unsteady-state/0.7		-	604	74	-	87.7
		Total/6.1		-	1760	94	-	94.6
3	399 (750)	Steady-state/4.4	E	5.94 (1170)	2910	115	42 (75)	96.0
		Unsteady-state/1.0		-	729	29	-	96.0
		Total/5.4		-	2500	99	-	96.0
		Steady-state/1.9	F	4.17 (820)	2070	84	39 (71)	95.9
		Unsteady-state/7.3		-	933	44	-	95.3
		Total/9.2		-	1170	52	-	95.6

[a] Does not include time periods in which (1) instruments were undergoing calibration and (2) the incinerator was shut down.

[b] Value is highly variable and, therefore, not calculated or monitored.

[c] Destruction Efficiency = $\frac{M_{in} - M_{out}}{M_{in}} \times 100\%$, where

$$M = \text{THC mass rate} = \frac{(V)\text{ moles C}}{10^6\text{ moles gas}} \times \frac{12\text{ gC}}{\text{mole C}} \times \frac{\text{mole gas}}{0.0237\text{ m}^3\text{gas}} \times \frac{(Q)\text{ m}^3\text{ gas}}{\text{sec}}$$

V = THC concentration, ppmc (in or out)
Q = gas flow rate, Nm^3/sec (in or out)

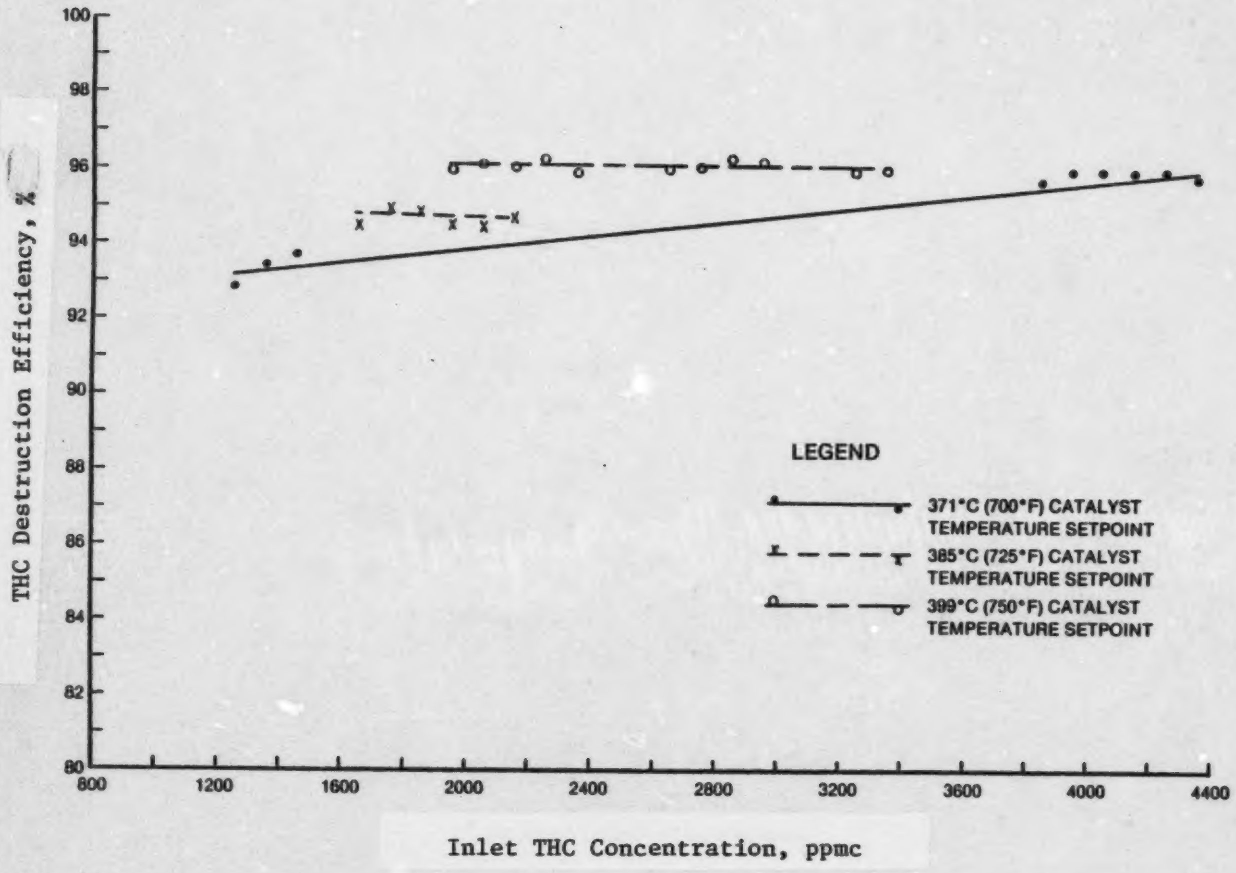

Figure 5-3. Effect of inlet THC concentration and catalyst temperature setpoint on THC destruction efficiency--Incinerator 21.

setpoint for a given inlet THC concentration. This result is in agreement with that determined previously for incinerator 20.

System Operation--In terms of destruction efficiency, incinerator performance was relatively constant regardless of the operating conditions; i.e., both steady- and unsteady-state press operation resulted in a narrow range of incinerator destruction efficiencies.

However, the nature of the press operating conditions has a pronounced effect on THC concentration and catalyst temperature profiles, as shown for the example time period in Figure 5-4. Of particular interest are the smooth catalyst temperature trends and the low exhaust gas THC concentrations, as compared to the performance trends for incinerator 20, shown previously in Figure 5-2. These results are consistent with the greater THC destruction efficiency of incinerator 21.

Catalyst Age--The catalyst in incinerator 21 had been in service for nine months when the testing was performed, only half of the age of the catalyst in incinerator 20. The fresher catalyst charge for incinerator 21 apparently contributed to its higher THC destruction efficiencies of 93 to 96 percent, which were consistent with vendor specifications.

5.2.2 EPA Draft Reference Method 18 Results

Information gained by EPA Draft Reference Method 18 at Plant C-3 was predominantly qualitative. Figure 5-5 illustrates typical data obtained by this chromatographic method. The system blank (upper chromatogram) was of acceptable quality, although it exhibited a pronounced baseline rise due to the rapid temperature programming and high GC oven temperatures needed to speciate natural gas components (C_1-C_5) and the solvent (C_{12}-C_{18}) within the same analysis. (The baseline rise does not contribute to the detected hydrocarbon peak areas and thus was not included in the calculation of hydrocarbon concentrations).

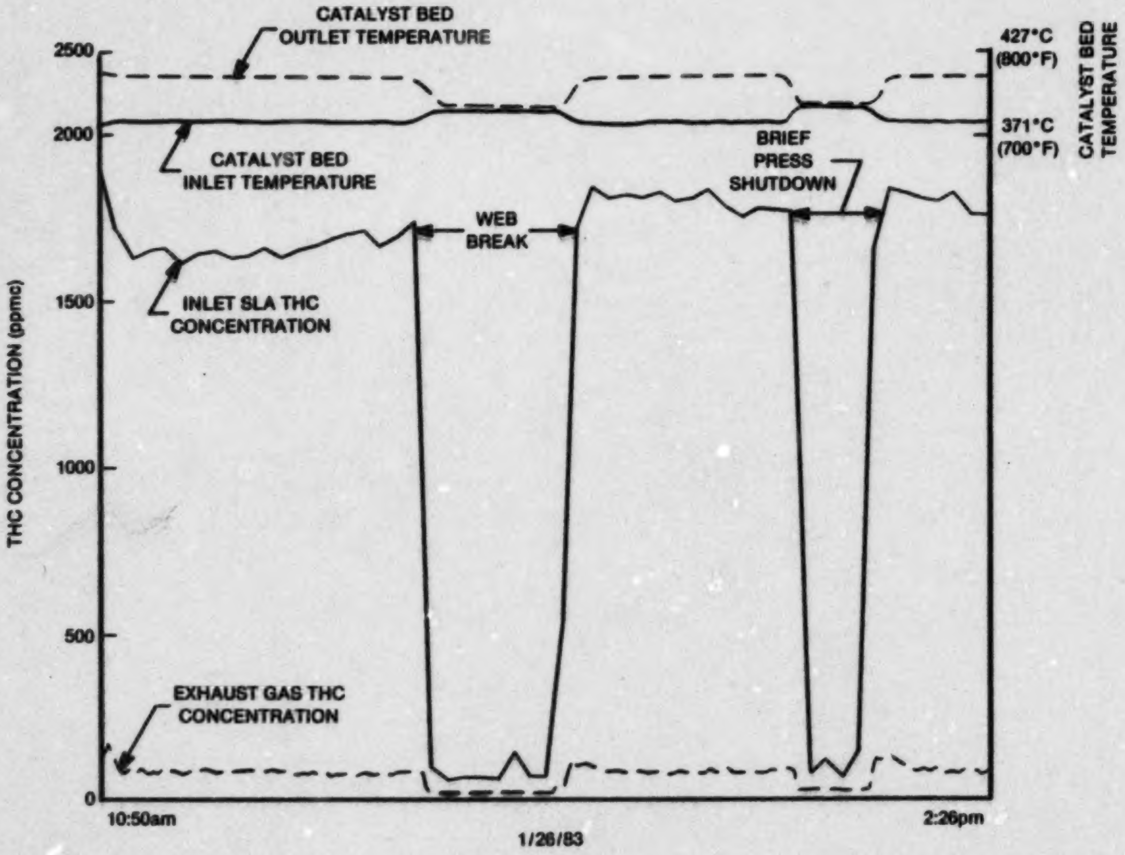

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Figure 5-4. Example THC and Catalyst Temperature Profiles--Incinerator 21

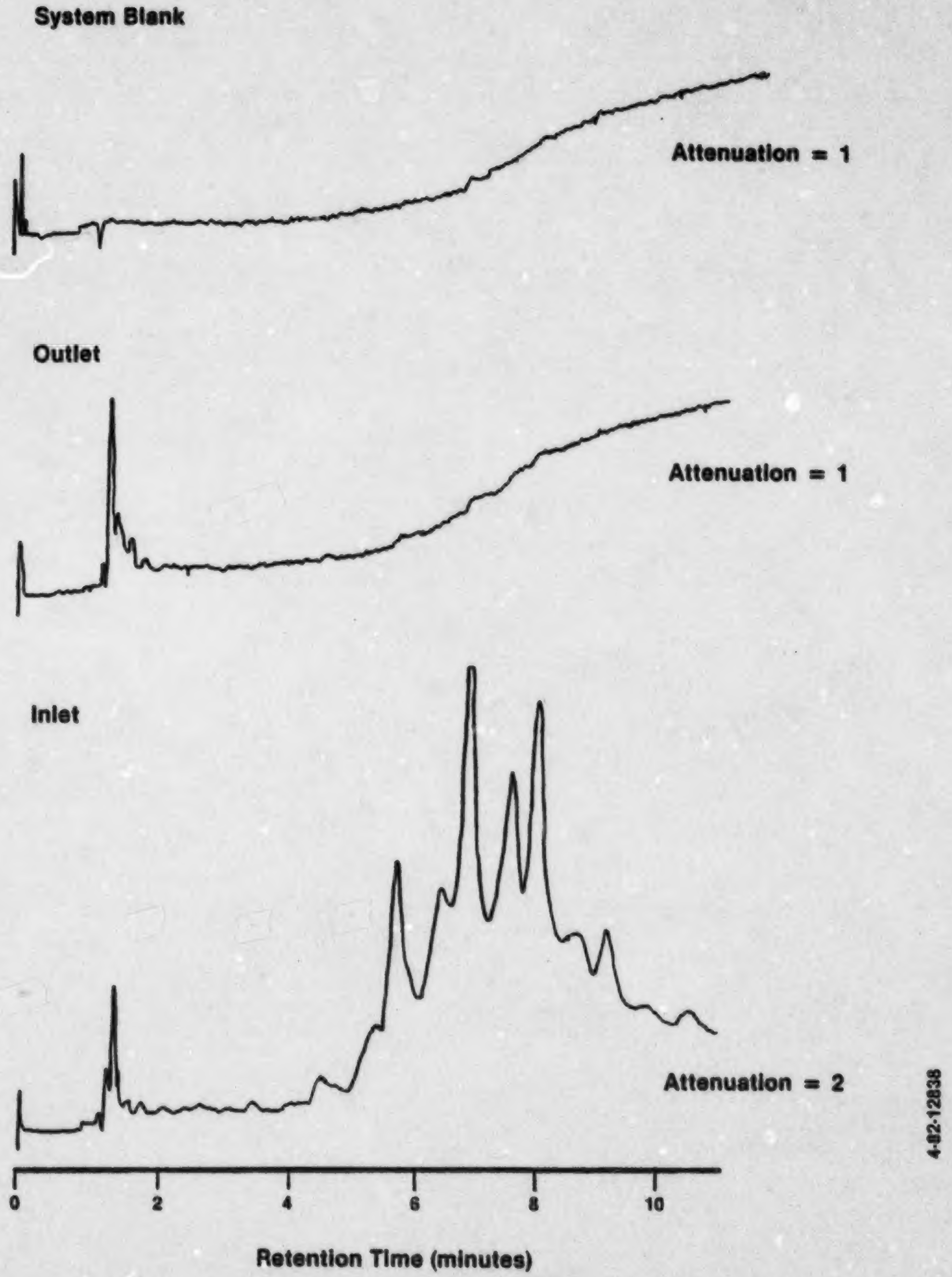


Figure 5-5. Typical gas chromatograms of inlet, outlet and system blank.

The outlet gas (middle chromatogram) resembles the blank except for the presence of unburned natural gas species at retention times of 1.4 to 1.8 minutes. No heavier organics are apparent in the chromatogram shown, although outlet gas samples often contained heavier compounds, as presented in Appendix F.

The presence of few or no heavier organics in the outlet gas contrasts sharply with the inlet gas analysis (lower chromatogram), which indicates significant concentrations of heavier organics (C_{12}-C_{18}) at retention times of five to 10 minutes, in addition to the lighter natural gas species (from the printing press drying ovens). Comparison of typical inlet and outlet analyses suggests that, whereas certain natural gas species survive incineration, most or all of the solvent components are destroyed. As a result, the total destruction efficiency, which includes the effect of unburned natural gas components, is somewhat lower than the solvent destruction efficiency.

The inlet chromatogram shown in Figure 5-5 illustrates a typical distribution of organics for the Plant C-3 Method 18 analysis. The C_{12}-C_{18} species were not adequately separated on the packed column to quantify individual species. What appears to be a baseline rise and fall is simply the separated species eluting. Due to the inherent difficulty of the chromatographic separations and integration, poor quantitative reproducibility was experienced. Neither EPA Method 25A nor draft Method 18 is designed or validated for heavy organics, especially in the C_{12}-C_{18} hydrocarbon ranges.

The results of the EPA Method 18 analysis, as listed in Appendix F, were variable to the extent that the effects of incinerator operating temperature could not be observed. This variability was due to the printing process as well as the analytical method. Therefore, the data for each incinerator were combined to obtain two total destruction efficiency values, as summarized in Table 5-5. The tabulated average destruction efficiencies exhibit the same trends as the Method 25A analysis, i.e., the destruction efficiency of incinerator 20, 78 percent, is less than that of incinerator 21, 87 percent. However, the large variability assigned to the measured values based on process

TABLE 5-5. SUMMARIZED EPA METHOD 18 RESULTS--INCINERATORS 20 AND 21

Incinerator	Average Inlet Concentration (Ci), ppmc[a]	Average Outlet Concentration (Co), ppmc[a]	Average Destruction Efficiency, %[b]
20	1850±390[c]	410±16	78±27
21	1410±580	180±200	87±56

[a] Represents composite data obtained during steady-state press/incinerator operation.

[b] Destruction Efficiency $= \frac{M_{in} - M_{out}}{M_{in}} \times 100\%$, where

$$M = \text{THC mass rate} = \frac{(V)\ \text{moles C}}{10^6\ \text{moles gas}} \times \frac{12\text{g C}}{\text{mole C}} \times \frac{\text{mole gas}}{0.0237\ \text{m}^3\ \text{gas}} \times \frac{(Q)\ \text{m}^3\ \text{gas}}{\text{sec}}$$

V = THC concentration, ppmc (in or out)

Q = gas flow rate, Nm^3/sec (in or out)

[c] Significant variability of the printing process and the analytical method, especially for heavier organics, contributed to the overall uncertainty in the measured values.

and analytical variability prevents the accurate interpretation of quantitative results.

5.2.3 GC/MS Results

The results of the GC/MS analysis of the inlet and outlet of incinerators 20 and 21 are summarized in Table 5-6. The tabulated results are based on GC/MS analysis of (1) gas samples of the inlet and outlet streams collected in evacuated metal canisters and (2) condensed liquid samples of the inlet and outlet streams obtained from the EPA Method 4 moisture content sampling (measured concentrations of VOC's in the condensate samples were converted to concentrations in the gas phase by factoring in the sampled gas volumes).

In general, the inlet hydrocarbons to incinerators 20 and 21 consisted primarily of heavy alkanes (C_7-C_{17}) and aromatic solvent constituents (toluene, benzene, and naphthalene). Ethanol, which is commonly added to coating slurries as a thinning agent, was also detected in some samples.

Outlet hydrocarbons from the incinerators consisted of (1) the same plus additional lighter alkanes as measured in the inlet, but at significantly lower concentrations; (2) the same aromatics as in the inlet at approximately the same concentrations; and (3) low- to mid-molecular weight alkanes and furan, which apparently represent unburned natural gas species and reaction compounds, respectively.

The quantitation of compounds by GC/MS is less accurate than their identification. Therefore, the data in Table 5-6 are reported in qualitative relative concentrations, based on the ppmc values tabulated in Appendix K. Also, although the results in Table 5-6 represent a composite of the GC/MS analysis of both gas-phase and liquid-phase samples, it must be noted that gas and liquid analyses are not particularly comparable or additive due to the different methods necessary to introduce the samples into the GC/MS system.

TABLE 5-6. SUMMARIZED GC/MS RESULTS--INCINERATORS 20 AND 21

	Incinerator 20 Relative Hydrocarbon Concentration[a]--		Incinerator 21 Relative Hydrocarbon Concentration[a]--	
Compound	Inlet	Outlet	Inlet	Outlet
$C_{5.5}$ alkane[b]				M
$C_{10.5}$ alkane[c]	H	M	H	H
C_{13} alkane	M	L	M	L
C_{14} alkane	H	L	H	L
C_{15} alkane	H	L	H	M
C_{16} alkane	M	L	H	L
C_{17} alkane	M	L	M	L
Cycloalkanes[d]	L		M	L
C_4-C_{12} alkenes		M		M
Benzene	M	M	M	M
Toluene	M	M	M	M
Naphthalene	M			
Ethanol			M	M
Furan		M		L

H = high, M = moderate, L = low

[a] GC/MS analysis provides data of order-of-magnitude accuracy. Therefore, concentration values are expressed in this table using a qualitative measure (H, M, or L), based on the GC/MS ppmc values tabulated in Appendix K.

[b] Represents alkanes in the C_4-C_7 range.

[c] Represents alkanes in the C_7-C_{14} range.

[d] Assumed to approximate, on a carbon number basis, the C_8 cycloalkane.

5.3 CO GENERATION

Results of the CO analysis performed on the exhaust gas from the Plant C-3 incinerators are summarized in Table 5-7. For incinerator 20, exhaust gas CO concentrations averaged 500 ppmc at normal operating temperatures. The CO emission level increased, rather than decreased, as the temperature setpoint was increased from 371°C (700°F) to 385°C (725°F), but this trend is probably related to the corresponding increase in inlet THC loading, from 1260 ppmc to 1610 ppmc.

For incinerator 21, outlet CO emissions were considerably higher at normal operating temperatures, averaging over 1000 ppmc. However, inlet THC concentrations during this time exceeded 4000 ppmc, a level two to three times higher than measured during the other time periods. During subsequent operation with catalyst temperature setpoints of 385°C (725°F) and 399°C (750°F), the incinerator exhausted CO at average levels of 490 ppmc and 400 ppmc, respectively, while inlet THC concentration remained relatively constant at about 2000 ppmc.

5.4 CONCLUSIONS

The following conclusions are drawn from results of the testing of the Plant C-3 catalytic incinerators:

- Incinerators 20 and 21 processed SLA at flow rates, temperatures, and residence times consistent with their design.
- Incinerator 21 destroyed VOC's more energy efficiently than incinerator 20 because of an additional level of heat recovery.
- Semi-continuous EPA Method 25A (THC) analysis indicated that incinerator 20 controlled VOC's at a destruction efficiency of 80 percent at a normal operating temperature of 371°C (700°F) and at steady-state conditions. Destruction efficiency increased to 87 percent at 399°C (750°F) and generally increased with inlet THC concentration. A somewhat deactivated catalyst charge may account for the relatively low THC destruction efficiencies. Temperature rise across the catalyst bed averaged less than 10°C (18°F).

TABLE 5-7. SUMMARIZED RESULTS OF CO ANALYSIS--INCINERATORS 20 AND 21[a]

Incinerator	Catalyst Temperature Setpoint	Inlet THC Concentration, ppmc[b]	Outlet THC Concentration, ppmc[b]	Outlet CO Concentration, ppmc
20	371°C (700°F)	1260	255	500
	385°C (725°F)	1610	262	540
	399°C (750°F)	--[c]	--[c]	--[c]
21	371°C (700°F)	4210	177	1030
	385°C (725°F)	2010	106	490
	399°C (750°F)	1970	75	440

[a] Only data collected during periods of steady-state press/incinerator operation are reported.

[b] THC data reported are only those that were determined simultaneously with the CO data.

[c] Operation was not steady during analysis.

- Similar analysis of incinerator 21 indicated a steady-state destruction efficiency of 93 to 96 percent at normal operating temperatures. The destruction efficiency was relatively constant over the range of temperatures and inlet THC concentrations tested. The superior performance of incinerator 21 was apparently related to a more active catalyst. Temperature rise across the bed averaged about 40°C (72°F).

- Periodic EPA Method 18 (GC) analysis indicated that, for both incinerators, unburned natural gas species accounted for a large fraction or all of the hydrocarbons in the exhaust gas. This suggests that the incinerators destroy solvent hydrocarbons with greater efficiency than indicated by the total destruction efficiency. Average destruction efficiencies of incinerators 20 and 21 as measured by EPA Method 18 were 78 and 87 percent, respectively. However, these average values include large uncertaintites, due to both variability in both the printing process and in the analytical method.

- GC/MS analysis of the inlet and outlet gas streams from the incinerators confirmed that the inlet hydrocarbons consisted primarily of heavy solvent components--C_7 to C_{17} alkanes and aromatics. The outlet gas generally contained the same species as the inlet gas, although at typically lower concentrations. In addition, lighter unburned natural gas species and miscellaneous low-level reaction compounds were detected only in the outlet gas.

- Analysis of the exhaust gas from the incinerators for CO content indicated that, at typical inlet VOC concentrations of about 2000 ppmc, outlet CO concentrations averaged 500 ppmc. Also, CO emissions were not particularly dependent on incinerator operating temperature for the range of conditions tested.

APPENDIX A

DETAILED TEST METHODS

The primary objective of the test program conducted at Plant C-3 was to characterize the performance of the catalytic incinerators at different operating conditions. The sampling/analytical methodologies developed to meet this objective, which were previously described in the Plant C-3 test plan (4-1), are summarized in this section.

A.1 SAMPLING LOCATIONS

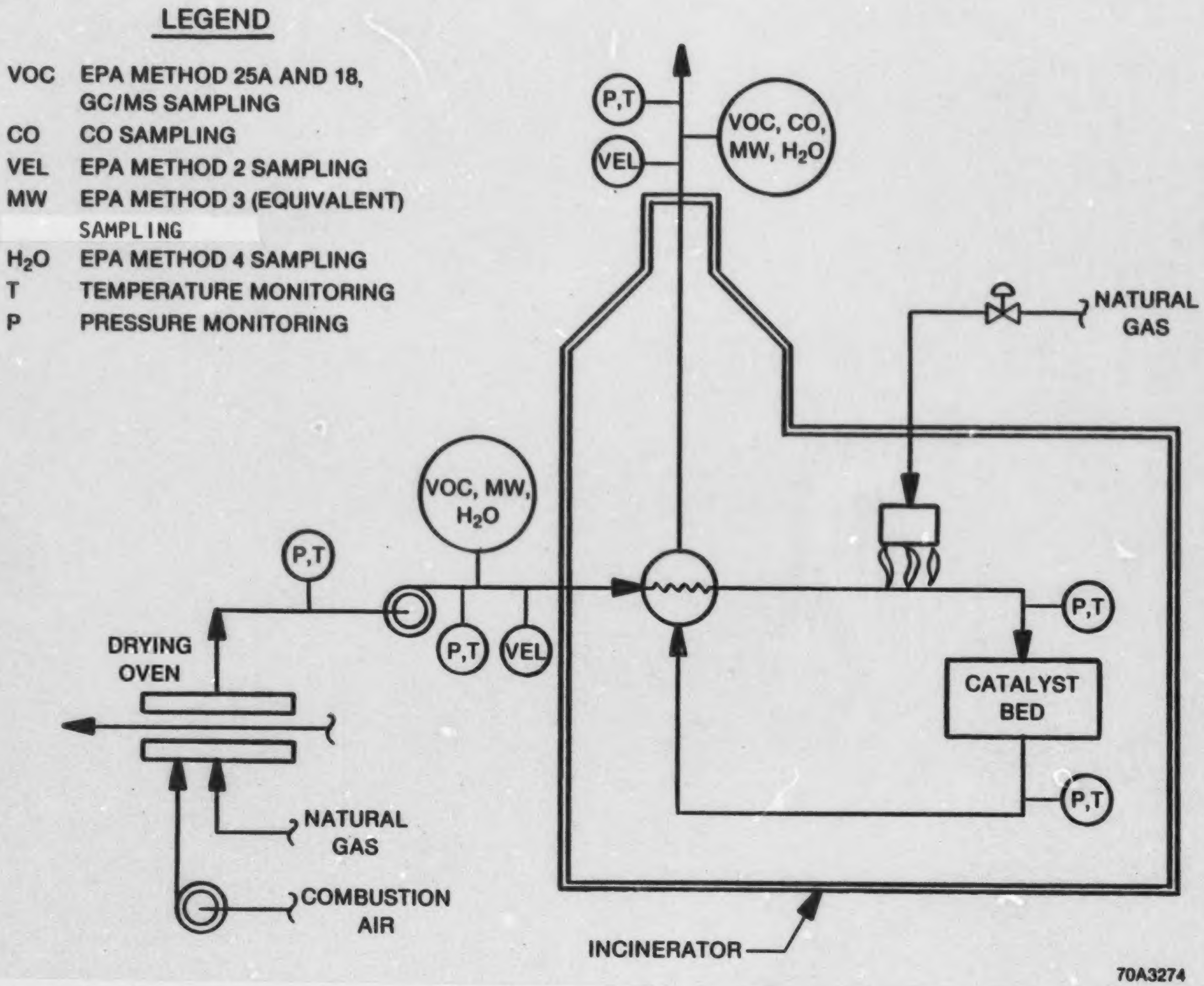
Sampling locations for the Plant C-3 catalytic incinerators are shown in Figures A-1 and A-2. Procedures used to sample at the locations shown in the figures are described in the following section.

A.2 SAMPLING PROCEDURES

The sampling procedures used to characterize operation of the Plant C-3 incinerators are summarized in Table A-1 and are discussed in the following subsections.

A.2.1 Sample Acquisition for VOC, CO, and Fixed Gas Analysis

Three-hole stainless steel rake-type sampling probes were installed in the inlet and outlet ducts in accordance with the protocol specified in EPA Proposed Reference Method 25A to provide gas samples for VOC, CO, and fixed gas analysis. The probes were connected to 150-foot (inlet) and 150-foot (outlet) heat-traced (120°C) Teflon® sampling umbilicals for transport of the gas samples to the analaytical instruments.



LEGEND

VOC	EPA METHOD 25A AND 18, GC/MS SAMPLING
CO	CO SAMPLING
VEL	EPA METHOD 2 SAMPLING
MW	EPA METHOD 3 (EQUIVALENT) SAMPLING
H_2O	EPA METHOD 4 SAMPLING
T	TEMPERATURE MONITORING
P	PRESSURE MONITORING

P,T
VOC, CO, MW, H₂O
VEL
NATURAL GAS
VOC, MW, H₂O
P,T
DRYING OVEN
P,T
VEL
P,T
CATALYST BED
P,T
NATURAL GAS
COMBUSTION AIR
INCINERATOR
70A3274

Figure A-1. Sampling Locations--Incinerator 20

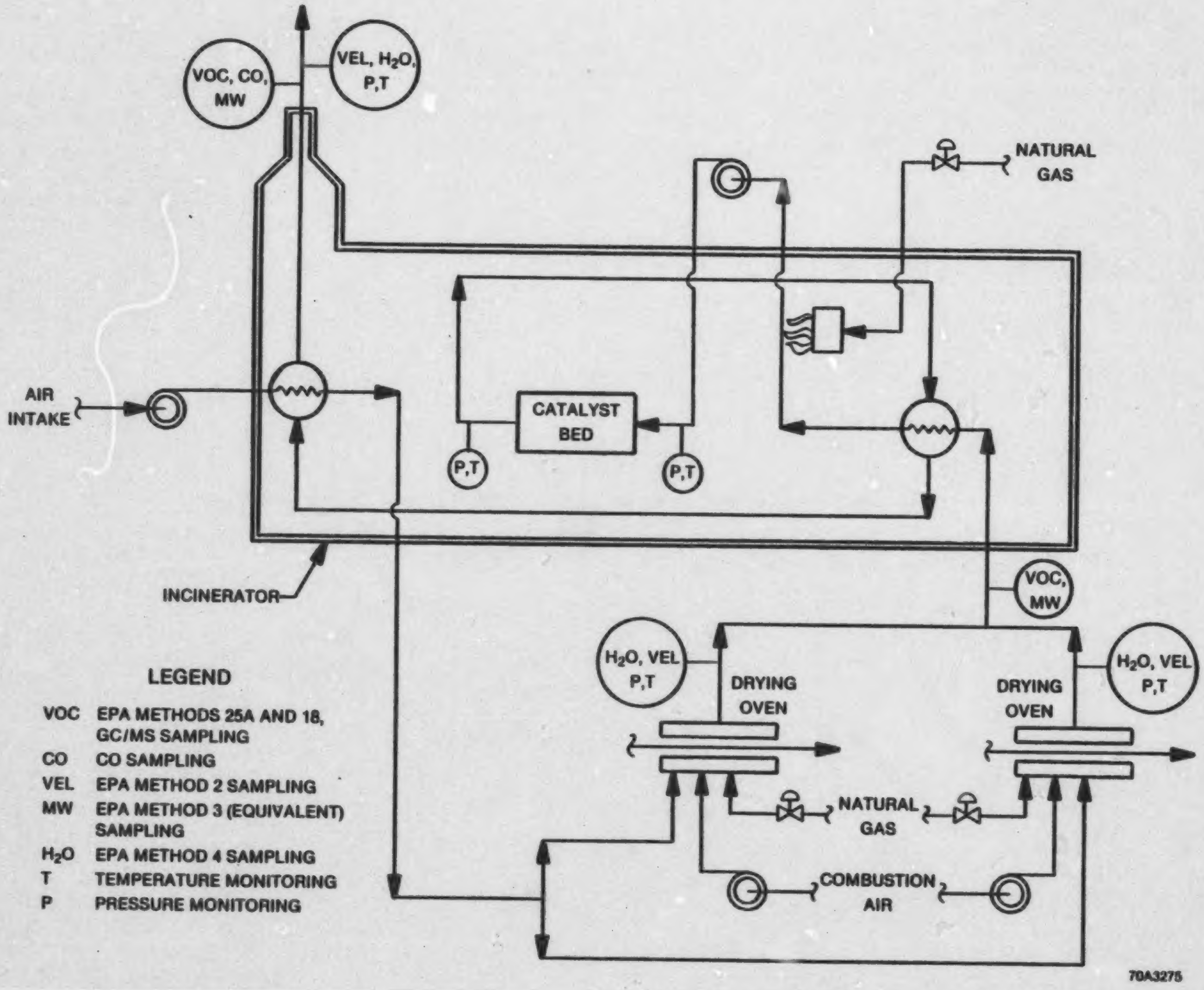

VOC, CO, MW
VEL, H2O, P,T
NATURAL GAS
AIR INTAKE
CATALYST BED
P,T
P,T
INCINERATOR
VOC, MW
H2O, VEL P,T
DRYING OVEN
H2O, VEL P,T
DRYING OVEN
NATURAL GAS
COMBUSTION AIR
LEGEND
VOC EPA METHODS 25A AND 18, GC/MS SAMPLING
CO CO SAMPLING
VEL EPA METHOD 2 SAMPLING
MW EPA METHOD 3 (EQUIVALENT) SAMPLING
H2O EPA METHOD 4 SAMPLING
T TEMPERATURE MONITORING
P PRESSURE MONITORING
70A3275

Figure A-2. Sampling Locations--Incinerator 21

E-51

TABLE A-1. SAMPLING PROCEDURES

Parameter	Sampling Location	Sampling Procedure
Hydrocarbon Concentration	Inlet/Outlet	EPA Proposed Reference Method 25A (Section A.2.1)
Hydrocarbon Species Identification	Inlet/Outlet	EPA Proposed Reference Method 25A; evacuated canister equipped with vacuum flow regulator for low molecular weight compounds and extracts of condensibles for high molecular weight compounds (Section A.2.1)
CO Concentration	Outlet	EPA Proposed Reference Method 25A (Section A.2.1)
Molecular Weight (Fixed Gases)	Inlet/Outlet	EPA Proposed Reference Method 25A (Section A.2.1)
Moisture Content	Inlet/Outlet	EPA Reference Method 4 (Section A.2.2)
Velocity/Volumetric Flow Rate	Inlet/Outlet	EPA Reference Methods 1 and 2 (Section A.2.3)
Temperature	See Figures A-1 & A-2	K-type thermocouple (Section A.2.4)
Pressure	See Figures A-1 & A-2	Magnehelic® gauge (Section A.2.4)
Process Data	Various	Plant instrumentation and documentation (Section A.2.5)

From the sampling umbilicals, the gas samples were introduced to heat-traced (120°C) stainless steel manifolds for distribution to the various analytical instruments, as shown in Figure A-3. High-temperature VOC adsorption-resistant sampling pumps were used to deliver the gas samples through the analytical train. Water-cooled impinger trains were used to condense moisture and organics in the gas samples immediately before introduction to the fixed gas analyzer.

Samples for hydrocarbon species identification by off-site gas chromatography/mass spectrometry (GC/MS) were obtained by two procedures. Evacuated metal canisters were used to collect gas samples for lighter organics analysis. The samples were obtained from the heated sampling manifolds. Samples for GC/MS analysis for heavy organics were obtained by extracting the impinger condensate catch from the moisture content sampling.

A.2.2 Sample Acquisition for Moisture Content Analysis

Samples for moisture content analysis of the incinerator inlet and outlet streams were obtained according to the sampling procedures prescribed in EPA Reference Method 4. By this method, a measured volume of gas is pulled through a chilled impinger train. The quantity of water condensed in the impingers is determined gravimetrically and then related to the measured sample gas volume to determine moisture content. Figure A-4 illustrates the sampling train used for moisture determination.

After weighing the impinger condensate, it was extracted with methylene chloride. The organic phase was retained for GC/MS analysis for heavy organics.

A.2.3 Sampling for Velocity/Volumetric Flow Rate

Pitot tube traverses of the gas streams were performed in accordance with EPA Reference Methods 1 and 2 to determine gas velocity and volumetric flow rate. By these methods,

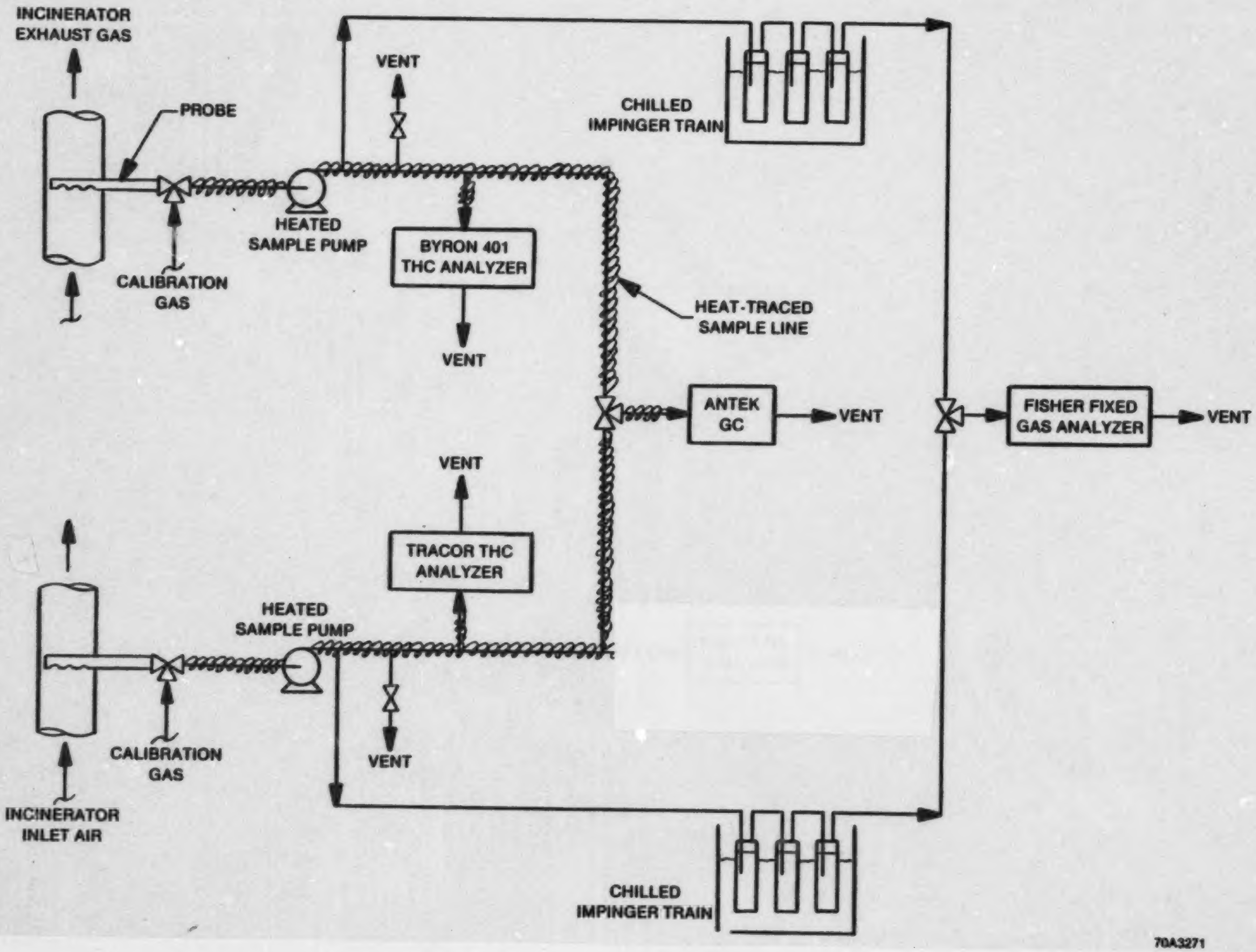

INCINERATOR
EXHAUST GAS
PROBE
CALIBRATION
GAS
HEATED
SAMPLE PUMP
VENT
BYRON 401
THC ANALYZER
VENT
CHILLED
IMPINGER TRAIN
HEAT-TRACED
SAMPLE LINE
ANTEK
GC
VENT
FISHER FIXED
GAS ANALYZER
VENT
VENT
TRACOR THC
ANALYZER
HEATED
SAMPLE PUMP
CALIBRATION
GAS
VENT
INCINERATOR
INLET AIR
CHILLED
IMPINGER TRAIN
70A3271

Figure A-3. Sampling and Analytical System--Plant C-3

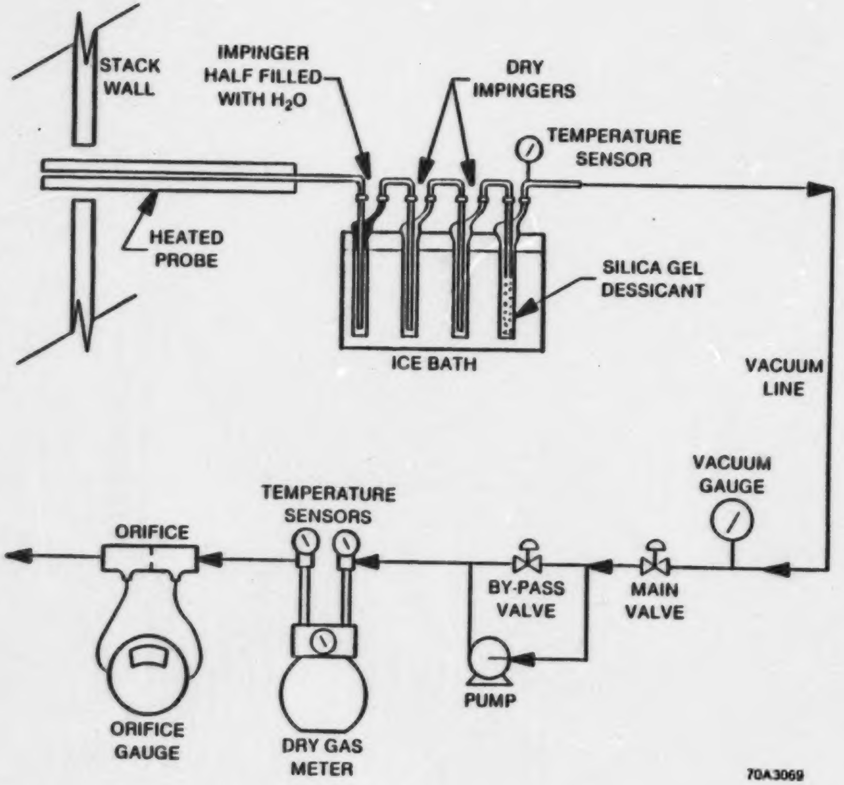

STACK WALL
IMPINGER HALF FILLED WITH H_2O
DRY IMPINGERS
TEMPERATURE SENSOR
HEATED PROBE
SILICA GEL DESSICANT
ICE BATH
VACUUM LINE
VACUUM GAUGE
TEMPERATURE SENSORS
ORIFICE
BY-PASS VALVE
MAIN VALVE
PUMP
ORIFICE GAUGE
DRY GAS METER
70A3069

Figure A-4. EPA Method 4 Moisture Sampling Train

$$V \propto \left[\frac{(\Delta P)(T)}{(MW)(Ps)}\right]^{1/2}, \text{ where}$$

V = average gas velocity

ΔP = average velocity pressure,

T = average absolute gas temperature,

MW = gas molecular weight, and

Ps = gas static pressure.

A.2.4 Temperature and Pressure Measurement

Process temperatures were monitored using calibrated K-type thermocouples and an Esterline Angus Model 1124E continuous temperature recorder. Pressure readings were taken with calibrated Magnehelic® gauges and an inclined manometer.

A.2.5 Measurement of Various Process Parameters

Plant instrumentation and data were used to measure or monitor certain process parameters, e.g., web speed.

A.3 ANALYTICAL PROCEDURES

The sampling procedures previously described were used to provide samples or information for analysis. The analytical procedures used to characterize incinerator performance are summarized in Table A-2 and are discussed in the following subsections.

A.3.1 Hydrocarbon Concentration (THC) Analysis

A Tracor Model 560 GC, operated with the gas sample introduced directly to the FID, was used to measure inlet THC concentrations at four-minute intervals. Another FID-based instrument, the Byron 401 THC Analyzer, was used to monitor exhaust gas THC concentrations at one-minute intervals. The Byron

TABLE A-2. ANALYTICAL PROCEDURES

Parameter	Analytical Procedure
Hydrocarbon Concentration (THC)	EPA Proposed Reference Method 25A (Section A.3.1)
Hydrocarbon Concentration (Speciated)	EPA Draft Reference Method 18 (Section A.3.2)
Hydrocarbon Species Identification	Gas Chromatography/Mass Spectrometry (GC/MS) (Section A.3.3)
CO Concentration	Byron Model 401 THC Analyzer--Full Scan Mode (Section A.3.4)
Molecular Weight (Fixed Gases)	EPA Reference Method 3 (Equivalent) (Section A.3.5)
Moisture Content	EPA Reference Method 4[a]
Velocity/Volumetric Flow Rate	EPA Reference Methods 1 and 2[a]
Temperature	K-type thermocouple[a]
Pressure	Magnehelic® gauge[a]
Process Data	Plant instrumentation and documentation[a]

[a] Discussed in Sampling Procedures (Section A.2).

401 Analyzer is depicted in Figure A-5. The THC analyzers were calibrated with propane-in-nitrogen standards, and THC concentrations were expressed as parts per million as carbon (ppmc).

All data from the Byron analyzer, i.e., THC concentrations, sample time, and sampling location, were automatically captured, stored on magnetic disk, and reduced using an Apple® II microcomputer system.

A.3.2 Hydrocarbon Concentration (Speciated) Analysis

An Antek Model 460 gas chromatograph was used to perform speciation of the VOC's in the incinerator inlet and outlet gases according to EPA Draft Reference Method 18. The GC uses an FID for individual species quantitation and was operated with the following analytical conditions:

Column: 10' x 1/8" OD SS, 10% OV-101 on 80/100 mesh Supelcoport

Carrier Gas: Nitrogen, 30 ml/min

Temperature Program: 150°C for 3 min, 15°C/min to 200°C, 200°C until elution was complete

Injection: 1 ml fixed volume loop

Ingegrator: Hewlett Packard 3390A

The GC was calibrated with propane standards. Organic species were measured on a retention time basis. Concentrations were expressed as ppmc.

A.3.3 Hydrocarbon Species Identification Analysis

A Hewlett Packard Model 5982 GC/MS was used for off-site analysis of incinerator inlet and outlet samples in an effort to qualitatively identify organic species. As described in Sections A.2.1 and A.2.2, the collected samples were of two types: (1) gas samples collected in evacuated metal canisters

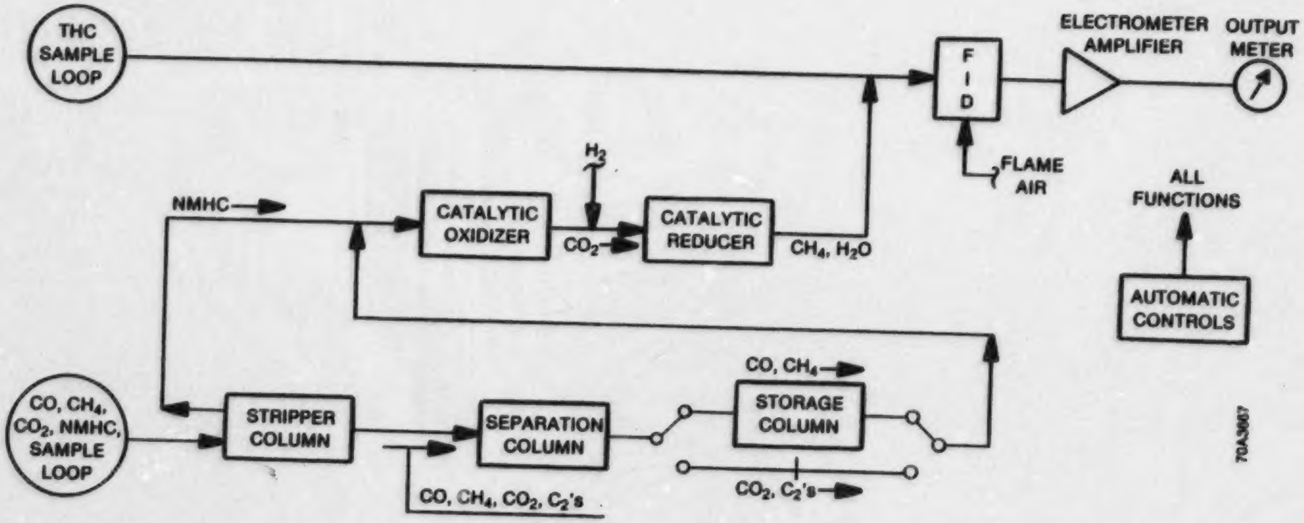

THC SAMPLE LOOP
F I D
ELECTROMETER AMPLIFIER
OUTPUT METER
FLAME AIR
H_2
NMHC
CATALYTIC OXIDIZER
CO_2
CATALYTIC REDUCER
CH_4, H_2O
ALL FUNCTIONS
AUTOMATIC CONTROLS
CO, CH_4, CO_2, NMHC, SAMPLE LOOP
STRIPPER COLUMN
SEPARATION COLUMN
CO, CH_4, CO_2, C_2's
CO, CH_4
STORAGE COLUMN
CO_2, C_2's
70A3667

Figure A-5. Schematic diagram of Byron 401 THC Analyzer for light organics analysis and (2) liquid samples obtained by extracting the EPA Method 4 condensate for heavy organics analysis.

The identification of low molecular weight organics in inlet and exhaust streams was accomplished by GC/MS using a cryogenic trap to isolate sample components. The cryogenic trapping system is microprocessor-controlled with air actuated valves to maximize analytical reproducibility. The analytical conditions are summarized below:

Instrument	Hewlett-Packard 5982
Ionization voltage	70 eV
Scan rate	1 scan/sec
Scan range	35-200 amu
Column	30-meter DB5 bonded phase wide bore thick film
Initial temperature	-50°C
Program rate	8°C/min
Final temperature	200°C
Interface	Open split
Cryogenic trap temperature	-183°C
Desorption temperature	+250°C
Desorption time	10 min

The high molecular weight organic species obtained in the extraction of the condensate during the determination of moisture content were injected on to an SE-54 capillary column. The conditions were the same as the low molecular weight organic species determinations above except that the initial and final temperatures were 50°C and 250°C, respectively, and the amu scan range was set at 50 to 350 amu.

A total ion chromatogram was obtained for each sample analysis. The peaks with the largest total ion area courts were identified from computer matches of the fragment patterns and operator judgment.

A.3.4 CO Content

CO concentrations of the incinerator exhaust gas were periodically measured by the Byron 401 Analyzer operating in the "Full Scan" (FS) mode. In this mode, a portion of the gas sample is introduced directly to the FID, yielding a THC measurement. Subsequently, NMHC, CH_4, CO_2, and CO are chromatographically separated from a separate injection of the gas sample. One at a time, each of these groups is passed through an oxidizer/reducer to convert all carbon to CH_4. These reduced streams are then individually introduced to the FID for measurement, with a complete cycle requiring 12 minutes. The schematic shown earlier in Figure A-5 illustrates the basic operating logic of the Byron 401 analyzer in the FS mode.

A.3.5 Fixed Gas Analysis

A Fisher Model 1200 Gas Partitioner was used for fixed gas (N_2, O_2, and CO_2) analysis of the inlet and outlet gas streams in a manner equivalent to that specified in EPA Reference Method 3. This instrument uses dual columns and dual thermal conductivity detectors and was calibrated with fixed gas standards according to the QC protocol established for this program. Concentrations of N_2, O_2, and CO_2 were determined in volume percent. The analytical conditions for this instrument were as follows:

- Column 1: 1/8" x 6.5' aluminum tubing packed with 80-100 mesh C Columnpak PQ
- Column 2: 3/16" x 11" aluminum tubing packed with 60-80 mesh Molecular Sieve 13X.
- Oven temperature: 50°C
- Bridge current: 225 mA
- Carrier gas: 8.5% H_2 in He at 30 cc/min

The CO_2, O_2, and N_2 data as determined with the Fisher Gas Partitioner were combined with the EPA Reference Method 4 moisture content data to yield a wet molecular weight, which was used in the calculation of gas velocity according to EPA Reference Method 2.

APPENDIX B

QUALITY CONTROL

Thorough quality control (QC) procedures were followed during this test program. These procedures covered all aspects of the sampling and analysis and were designed to document the precision, accuracy, and adequacy of all data collected. In general, the QC activities involved calibration of instruments and sampling equipment against certified standards.

Analytical measurements for VOC's were made with (1) a Byron Super 401 analyzer and a Tracor Model 560 GC-FID for EPA Proposed Method 25A, (2) an Antek Model 460 GC-FID for EPA Draft Reference Method 18, and (3) a Hewlett-Packard Model 5982 GC/MS for qualitative VOC compound identification. The Byron Super 401 was used for CO measurements, and a Fisher Model 1200 Gas Partitioner was used for fixed gas analysis (equivalent to EPA Reference Method 3). In addition, process variable measurements involved the use of routine sampling equipment, such as pitot tubes, Magnehelic® pressure gauges, temperature measuring devices, a dry gas meter, and an analytical balance. QC procedures and results are presented in the following subsections.

B.1 ANALYTICAL INSTRUMENT CALIBRATION

While on site, the Byron analyzer, the Tracor THC analyzer, the GC-FID instrument, and the Fisher Gas Partitioner were calibrated daily. The GC/MS instrument, used for off-site analysis of samples, was also subjected to appropriate QC procedures. Extensive discussion of the analytical procedures used and details of the results are presented in a separate QC document (Volume 9) to be submitted with the final project report. This information is summarized below.

B.1.1 Byron Super 401 and Tracor THC Analyzer Calibrations

Calibration of the THC instruments involved daily analysis of a series of NBS-traceable propane-in-nitrogen standards. The linearity of each analyzer was verified by the correlation coefficient obtained from this series of standards. An average response factor (RF) was also determined and used to calculate a running mean. In order to provide sufficient precision and accuracy, the calibration data required a correlation coefficient greater than 0.9950 and the daily average RF was required to be within 10 percent of the running mean RF. Summaries of the propane multipoint calibrations are given in Table B-1 for the Byron 401 analyzer and Table B-2 for the Tracor THC analyzer. All acceptance criteria were met for both instruments during the entire test period.

B.1.2 Byron 401 CO Analyzer Calibrations

Calibration of the Byron Super 401 analyzer for CO determinations was accomplished by a multipoint calibration against certified (within 2 percent) standards of CO in N_2. The acceptance criteria for this analysis are identical to those for the propane calibrations. The data are summarized in Table B-3 and show that all acceptance criteria were met.

B.1.3 Antek GC/FID VOC Analyzer Calibrations

Multipoint calibration of the GC/FID was performed daily using the same standards and manifold lines as the Byron Super 401. A correlation coefficient greater than 0.9950 was required for these data. A summary of the calibration data is given in Table B-4.

As the data show, the correlation coefficient for each multipoint exceeds the minimum of 0.9950. However, the calculated analytical blank concentrations are shown to be high. These values reflect the effects of residual material on the column and in the sampling system.

TABLE B-1. PROPANE MULTIPOINT CALIBRATIONS--BYRON SUPER 401 ANALYZER

Date	VOC in Zero Air (ppmc)[a]	Low Standard RF[b]	Medium Standard RF[c]	High Standard RF[d]	Average RF	Correlation Coefficient	Running Mean RF	Meets All Criteria[e]
1/19/83	0.44	0.8346	0.9080	0.9352	0.8926	0.9999	0.8926	Yes
1/20/83	0.47	0.8900	0.9119	0.9791	0.9270	0.9999	0.9098	Yes
1/22/83	0.47	0.9255	0.9278	0.9511	0.9348	0.9999	0.9181	Yes
1/23/83	0.47	0.8900	0.9436	0.9631	0.9322	0.9999	0.9217	Yes
1/24/83	0.71	1.004	0.9674	1.015	0.9954	0.9999	0.9364	Yes
1/26/83	3.29[f]	0.9414	0.9595	0.9911	0.9640	0.9999	0.9410	Yes
1/27/83	3.77[f]	1.004	1.007	1.015	1.008	0.9999	0.9506	Yes
1/28/83	3.51[f]	0.9651	1.022	1.031	1.006	0.9999	0.9575	Yes

[a] Concentration in analytical blank calculated from average RF.

[b] Concentration = 9.918 ppmc.

[c] Concentration = 98.94 ppmc.

[d] Concentration = 981.6 ppmc.

[e] Acceptance criteria were a correlation coefficient >0.9950 and the average RF within 10% of the running mean RF.

[f] Breathing air used for blank due to unavailability of zero grade air.

TABLE B-2. PROPANE MULTIPOINT CALIBRATIONS--TRACOR THC ANALYZER

Date	VOC in[a] Zero Air (ppmc)	Low[b] Standard RF	Medium[c] Standard RF	High[d] Standard RF	Average RF	Correlation Coefficient	Running Mean RF	Meets[e] All Criteria
1/19/83	28	714	659	720	698	0.9999	698	Yes
1/21/83	27	739	675	738	717	0.9999	708	Yes
1/22/83	29	718	659	734	704	0.9999	706	Yes
1/23/83	29	788	707	777	757	0.9999	719	Yes
1/23/83	ND[f]	780	698	772	750	0.9999	725	Yes
1/24/83	32	740	703	777	740	0.9999	728	Yes
1/26/83	46[g]	751	654	781	729	0.9999	728	Yes
1/27/83	39[g]	783	715	826	775	0.9999	734	Yes
1/28/83	29[g]	779	715	ND	747	0.9999	735	Yes

[a] Concentration in analytical blank calculated from average RF.

[b] Concentration = 98.94 ppmc.

[c] Concentration = 981.6 ppmc.

[d] Concentration = 9510 ppmc.

[e] Acceptance criteria were a correlation coefficient >0.9950 and the average RF within 10% of the running mean RF.

[f] No data--analysis not performed.

[g] Breathing air used for blank due to unavailability of zero grade air.

TABLE B-3. CO MULTIPOINT CALIBRATIONS--BYRON SUPER 401 ANALYZER

Date	CO in[a] Zero Air (ppmc)	Low[b] Standard RF	Medium[c] Standard RF	High[d] Standard RF	Average RF	Correlation Coefficient	Running Mean RF	Meets[e] All Criteria
1/20/83	0	0.6964	0.7332	0.7581	0.7292	0.9999	.7292	Yes
1/22/83	0.06	0.6739	0.7020	0.7347	0.7035	0.9999	.7164	Yes
1/23/83	0.37	0.6964	0.7254	0.8128	0.7448	0.9999	.7258	Yes
1/24/83	0.05	0.6814	0.7566	0.8518	0.7632	0.9999	.7351	Yes
1/26/83	0[f]	0.7887	0.8112	1.031	0.8761	0.9999	.8761[g]	Yes
1/27/83	0.04[f]	0.8086	0.8501	1.008	0.8889	0.9999	.8825	Yes
1/28/83	0.05[f]	0.8236	0.8267	0.8440	0.8314	0.9999	.8655	Yes

[a] Concentration in analytical blank calculated from average RF.

[b] Concentration = 50.3 ppmc.

[c] Concentration = 52.4 ppmc.

[d] Concentration = 502 ppmc.

[e] Acceptance criteria were a correlation coefficient >0.9950 and the average RF within 10% of the running mean RF.

[f] Breathing air used for blank due to unavailability of zero grade air.

[g] Carrier flow adjusted to improve separation between CH_4 and CO. A new running mean was obtained due to the different analytical conditions.

TABLE B-4. PROPANE MULTIPOINT CALIBRATION--ANTEK GC-FID ANALYZER

Date	VOC in[a] Zero Air (ppmc)	Low[b] Standard RF	Medium[c] Standard RF	High[d] Standard RF	Average RF	Correlation Coefficient	Meets[e] All Criteria
1/20/83	3	527	480	501	503	.9999	NO
1/22/83	9	848	720	739	769	.9999	NO
1/23/83	NA[f]	514	467	497	493	.9999	?
1/23/83	9	519	474	489	494	.9999	NO
1/24/83	4	554	513	529	532	.9999	NO
1/26/83	NA[f]	425	460	413	433	.9999	?
1/27/83	14[g]	526	504	515	515	.9999	NO
1/28/83	<20[g]	528	532	546	535	.9999	NO

[a] Concentration in analytical blank calculated from average RF.

[b] Concentration = 9.918 ppmc.

[c] Concentration = 98.94 ppmc.

[d] Concentration = 981.6 ppmc.

[e] Acceptance criteria were correlation ceofficient >0.9950.

[f] Not analyzed.

[g] Breathing air used for blank due to unavailability of zero grade air.

B.1.4 Fisher Gas Partitioner Fixed Gases Analyzer Calibrations

A multipoint calibration of the fixed gas analyzer was performed prior to and at the conclusion of testing for each incinerator. The standards were certified mixtures of CO_2 and O_2 in a balance of high purity N_2. Results of this calibration are given in Table B-5. CO_2, O_2, and N_2 calibrations are shown to have a correlation coefficient greater than 0.9950.

B.1.5 Tracor GC/FID Retention Time Calibration

To ensure proper flow rates and thus identification of each compound or group of compounds, a mixture of C_1 through C_7 hydrocarbons was analyzed on the Antek GC/FID. Retention times relative to C_3 were calculated for each compound. The values are given in Table B-6.

B.1.6 Mixed Gas Standard/CH_4 and CO_2 Calibrations

This calibration was not specified in the QA procedure but was performed to ensure proper operation and species separation for the Byron Super 401 analyzer. The standard gas was a certified mixture containing 19.7 parts per million by volume (ppmv) C_3H_8 (59.1 ppmc), 51.7 ppmv CH_4, 52.4 ppmv CO, and 18900 ppmv CO_2. Combining the CH_4 and C_3H_8 gave a THC concentration of 110.8 ppmc.

This standard was analyzed daily on the Byron analyzer to test all functions, particularly the separation and timing sequences. It also provided the only field calibration data for CH_4 on the instrument. The RF factors for these calibrations are presented in Table B-7. Since these calibrations are not specified in the QA plan, there are no acceptance criteria for the results.

For the Byron Super 401, the relative stability for all peaks is evident. However, the decreasing RF's for CO from 1/20/83 to 1/24/83 indicate a deterioration of the instrument's molecular sieve column. The carrier flow rate

TABLE B-5. FIXED GASES MULTIPOINT CALIBRATION--FISHER GAS PARTITIONER

Date	Compound[a]	Low[b] Standard RF	Medium[c] Standard RF	High[d] Standard RF	Average RF	Correlation Coefficient	Running Mean RF
1/19/83	CO_2	148	151	149	149	0.9999	149
	O_2	86.5	85.4	83.9	85.3	0.9999	85.3
	N_2	59.0	60.4	62.3	60.6	0.9999	60.6
1/24/83	CO_2	150	151	151	151	1.0000	150
	O_2	86.8	85.7	84.2	85.6	0.9999	85.4
	N_2	59.6	61.1	62.9	61.2	0.9996	60.9
1/28/83	CO_2	152	156	156	155	0.9999	152
	O_2	86.9	85.7	84.4	85.7	0.9999	85.5
	N_2	60.2	61.5	63.2	61.6	0.9999	61.1

[a] Standards were mixtures of CO_2 and O_2 in N_2.

[b] Concentrations were 2.01% CO_2, 9.96% O_2, and 67.2% N_2.

[c] Concentrations were 5.10% CO_2, 15.1% O_2, and 78.0% N_2.

[d] Concentrations were 10.0% CO_2, 22.8% O_2, and 88.0% N_2.

TABLE B-6. RELATIVE RETENTION TIME CALIBRATION[a]--ANTEK GC-FID

Date	C_1 RRT[b]	C_2 RRT	C_3 RRT	C_4 RRT	C_5 RRT	C_6 RRT	C_7 RRT
1/20/83	ND	ND	1.00[c]	ND	1.05	1.12	1.24
1/20/83	ND	ND	1.00	ND	1.05	1.14	1.28
1/22/83	ND	ND	1.00	ND	1.08	1.15	1.27
1/23/83	ND	ND	1.00	ND	1.07	1.15	1.27
1/24/83	ND	ND	1.00	ND	1.08	1.16	1.27
1/28/83	ND	ND	1.00	ND	1.07	1.15	1.27

[a] Temperature programmed from 150°C to 200°C at 15°C/min after initial hold of 3 minutes.

[b] Relative retention time.

[c] From propane multipoint calibrations.

ND = no data. Peaks coelute with C_3.

TABLE B-7. MIXED GAS CALIBRATIONS[a]--BYRON SUPER 401 ANALYZER

Date	THC RF	NMHC RF	CO RF	CH_4 RF	CO_2 RF
1/18/83	0.9489	1.115	0.8310	0.9485	1.068
1/18/83	1.076	1.181	0.8086	0.9636	1.037
1/18/83	0.9489	1.115	0.8086	0.9333	0.9859
1/19/83	0.9701	0.9757	0.8236	1.016	1.006
1/19/83	0.9630	1.068	0.7637	0.9788	1.079
1/19/83	0.9489	1.055	0.7787	0.9712	1.017
1/19/83	0.9630	1.042	0.8011	0.994	1.006
1/20/83	0.9489	1.028	0.6964	0.9636	1.037
1/22/83	0.9701	1.154	0.6739	0.8575	1.037
1/22/83	0.9984	1.168	0.6889	0.9181	0.9755
1/23/83	0.9630	1.108	0.6964	0.8954	0.9859
1/24/83	0.9984	1.632	0.6814	0.7816	0.9548
1/26/83	1.026	1.095	0.7861	0.8871	1.006
1/27/83	0.9984	0.9691	0.6664	0.8347	0.9444
1/27/83	1.104	1.154	0.8086	0.9636	1.068
1/28/83	0.9984	1.081	0.8236	0.9561	0.9755

[a] Concentrations were 19.7 ppmv C_3H_8 (59.1 ppmc), 51.7 ppmc CH_4, 52.4 ppmc CO, and 18900 ppmc CO_2. Combining the C_3H_8 and CH_4 gives a THC value of 110.8 ppmc.

was adjusted to optimize the separation between CH_4 and CO prior to testing the second incinerator (on 1/26/83).

B.1.7 Drift Check Calibrations

Each instrument's midpoint calibration standard was analyzed to test for drifting response. In all cases, this was done after analyzing for a long period (e.g., a full day). Since multipoint calibrations were performed for all VOC and CO analyzers on a daily basis, separate drift checks were not performed.

The data for these RF checks and drift checks for the fixed gas analyzer are given in Table B-8.

B.1.8 Control Standard Calibrations

All QC calibrations described thus far involved standards introduced to the sampling manifold and distribution system. Any problems associated with the heat-traced lines would not have been detected by these methods. To ensure the integrity of the heat-traced lines, VOC and fixed gas control standard gases were introduced into the heated line and analyzed on a daily basis.

These standards were analyzed after cleaning the heated line with zero air or breathing air and performing a system blank analysis. Each control standard analysis was performed in triplicate. Acceptance criteria in all cases were a coefficient of variation (CV) less than 5 percent and an average concentration within 10 percent of the running mean concentration. Results of all control standard tests are given in Tables B-9 and B-10. These tables show that all control standard acceptance criteria were met during the entire test period by all on-site analyzers.

TABLE B-8. DRIFT CHECK CALIBRATIONS--FISHER GAS PARTITIONER

Date	Compound[a]	RF	CV	Meets Requirements[b]
1/20/83	CO_2	144	3.3%	Yes
	O_2	85.2	0.1%	Yes
	N_2	60.3	0.4%	Yes
1/21/83	CO_2	147	1.9%	Yes
	O_2	85.3	0%	Yes
	N_2	60.8	0.2%	Yes
1/23/83	CO_2	149	0.9%	Yes
	O_2	85.8	0.4%	Yes
	N_2	61.1	0.6%	Yes
1/26/83	CO_2	151	0%	Yes
	O_2	85.7	0.1%	Yes
	N_2	61.1	0.1%	Yes

[a] Mid-point calibration standard containing 5.1% CO_2, 15.1% O_2, and 78.8% N_2 (balance).

[b] For RF checks, the requirements were a CV (with multipoint average RF) <20%. For drift checks, the requirements were agreement within 10% of the single point RF.

TABLE B-9. CONTROL STANDARD CALIBRATIONS--BYRON 401 AND TRACOR THC ANALYZERS

Instrument	Date	System Blank Concentration (ppmc)	Average Concentration (ppmc)	CV[a] (%)	Running Mean Concentration (ppmc)	Meets All Criteria	Comments
Byron 401[b]	1/19/83	1.3	103	4.6	103	Yes	Heated line
	1/19/83	0.7	108	0	106	Yes	Line at 143°C
	1/20/83	1.9	102	0	104	Yes	Heated line
	1/22/83	0.6	102	4.5	104	Yes	Heated line
	1/23/83	1.1	108	0	105	Yes	Heated line
	1/24/83	4.1	99.2	3.2	104	Yes	Line at 126°C
	1/24/83	3.4	98.7	2.5	103	Yes	Manifold
	1/27/83	3.5	99.6	2.0	103	Yes	Heated line
	1/28/83	3.4	99.0	0	102	Yes	Heated line
Tracor[c]	1/19/83		923	0.4	923	Yes	Heated line
	1/20/83		904	0.1	914	Yes	Heated line
	1/23/83		914	0.1	914	Yes	Heated line
	1/24/83		942	0.2	921	Yes	Line at 126°C
	1/24/83		926	0.7	922	Yes	Manifold
	1/27/83		877	0.8	914	Yes	Heated line
	1/28/83		887	0.2	910	Yes	Heated line
Tracor[b]	1/27/83		95.5	1.2	95.5	Yes	Heated line
	1/28/83		101	0.1	98.3	Yes	Heated line

[a] CV = coefficient of variation = $\frac{\text{standard deviation}}{\text{mean}}$ x 100%.

[b] Input concentration was 98.9 ppmc ±2%.

[c] Input concentration was 981 ppmc ±2%.

TABLE B-10. CONTROL STANDARD CALIBRATIONS--ANTEK GC-FID AND FISHER GAS PARTITIONER

Instrument	Date	Average Concentration (ppm)	CV[a] (%)	Running Mean Concentration (ppm)	Meets All Criteria	Comments
Antek[b]	1/20/83	93.5	1.5	93.5	Yes	Heated line
	1/20/83	113	0.8	103	Yes	Manifold
	1/22/83	86.2	0.8	97.4	Yes	Heated line
	1/23/83	97.5	1.3	97.4	Yes	Heated line
	1/24/83	91.8	0.4	96.3	Yes	Heated line
	1/24/83	92.0	0.3	95.6	Yes	Manifold
	1/27/83	98.0	1.5	95.9	Yes	Heated line
	1/28/83	99.9	0.5	96.4	Yes	Heated line
Antek[c]	1/20/83	945	1.4	945	Yes	Heated line
	1/20/83	935	1.6	940	Yes	Manifold
	1/22/83	906	0.6	929	Yes	Heated line
	1/23/83	996	0.1	946	Yes	Heated line
	1/24/83	941	0.7	945	Yes	Heated line
	1/24/83	952	1.0	946	Yes	Manifold
	1/27/83	978	3.4	950	Yes	Heated line
	1/28/83	928	0.6	948	Yes	Heated line
Fisher/CO_2[d]	1/19/83	5.02	0.3	5.02	Yes	Manifold
	1/19/83	4.86	0.2	4.94	Yes	Heated line
	1/19/83	4.87	0.6	4.92	Yes	Heated line
	1/21/83	5.08	0.1	4.96	Yes	Manifold
	1/21/83	5.11	1.0	4.99	Yes	Manifold
	1/23/83	5.03	0.5	5.00	Yes	Manifold
	1/24/83	5.09	0.6	5.01	Yes	Manifold
	1/26/83	5.20	1.7	5.03	Yes	Manifold
	1/27/83	5.20	0.8	5.05	Yes	Manifold
	1/28/83	5.24	2.4	5.07	Yes	Manifold

(Continued)

TABLE B-10. (Continued)

Instrument	Date	Average Concentration (ppm)	CV[a] (%)	Running Mean Concentration (ppm)	Meets All Criteria	Comments
Fisher/O_2[d] (continued)	1/19/83	15.0	0.4	15.0	Yes	Manifold
	1/19/83	14.9	0.4	15.0	Yes	Heated line
	1/19/83	15.1	0	15.0	Yes	Heated line
	1/21/83	15.1	0	15.0	Yes	Manifold
	1/21/83	15.1	0.7	15.0	Yes	Manifold
	1/23/83	15.0	0.4	15.0	Yes	Manifold
	1/24/83	15.1	0.7	15.0	Yes	Manifold
	1/26/83	15.0	0.4	15.0	Yes	Manifold
	1/27/83	14.9	0.4	15.0	Yes	Manifold
	1/28/83	15.0	0.4	15.0	Yes	Heated line
Fisher/N_2[d]	1/19/83	78.8	0	78.8	Yes	Manifold
	1/19/83	78.6	0.1	78.7	Yes	Heated line
	1/19/83	78.6	0.4	78.7	Yes	Heated line
	1/21/83	79.4	0.2	78.8	Yes	Manifold
	1/21/83	78.7	0.2	78.8	Yes	Manifold
	1/23/83	78.6	0.1	78.8	Yes	Manifold
	1/24/83	78.7	0.2	78.8	Yes	Manifold
	1/26/83	78.7	0.1	78.8	Yes	Manifold
	1/27/83	78.8	0.1	78.8	Yes	Manifold
	1/28/83	79.2	0.1	78.8	Yes	Heated line

[a] CV = coefficient of variation = $\frac{\text{standard deviation}}{\text{mean}} \times 100\%$.

[b] Input concentration = 98.9 ppmc ±2%.

[c] Input concentration = 981 ppmc ±2%.

[d] Input concentrations = 5.1% CO_2, 15.1% O_2, and 78.8% N_2 (balance).

B.1.9 GC/MS QC Activities

The GC/MS system was tuned using perfluorotributylamine (PFTBA). The calibration was checked using an on-column injection of 4-bromofluorobenzene (BFB). Table B-11 shows the criteria and results obtained for these analyses.

A performance test was run to evaluate capillary chromatography efficiency and system sensitivity. The system was found to be performing within the acceptable range for analysis (resolution of 0.75 to 1 and the capability to detect 10 ng benzo(a)pyrene monitoring mass/charge (m/e) ratio 252 ion).

All mass spectral data were collected and retained on magnetic disk during analysis. The data were later transferred on magnetic tape for permanent storage.

Two calibration standard mixtures were assayed. A Scott Environmental Technology certified gas standard (AAL-8823) was analyzed with the gas canister samples. Supelco's priority pollutant phenol mixture (604-m) was analyzed with the extracted samples. These standards were used to verify GC retention times and response data.

During the analysis of samples for Plant C-3 two quality control samples were analyzed. The results of this quality control procedure are listed in Table B-12. The four species were correctly identified; however, as expected, the quantitation by GC/MS was variable (approximately ± 50 percent).

A process using a three-step approach to the interpretation and identification of unknown compounds by their mass spectrum was used. The approaches are:

(1) Instant recognition of the mass spectrum.

(2) Manual interpretation of the mass spectrum--a step-by-step approach involving (a) verification of m/e assignments, (b) review of isotopic abundances for deduction of elemental composition,

TABLE B-11. GC/MS CALIBRATION RESULTS

Mass[a]	Ion Abundance Criteria	Results
50	15 to 40% of mass 95	19.1
75	30 to 60% of mass 95	58.1
95	Base peak, 100% rel abundance	100.0
96	5 to 9% of mass 95	6.7
173	>2% of mass 174	0.8
174	>50% of mass 95	58.1
175	5 to 9% of mass 174	6.5
176	>95% but <100% mass 174	105.0
177	5 to 9% of mass 176	6.2

[a] Using 50 ng 4-bromofluorobenzene (BFB).

TABLE B-12. QUALITY CONTROL DURING ANALYSIS OF PLANT C-3 SAMPLES

Compound	Correctly Identified	Input Concentration (2/4/83), ppmv	Input Concentration (2/9/83), ppmv	Approximate Measured Concentration, ppmv
Hexane	Yes	78	76	67
Octane	Yes	63	88	67
Benzene	Yes	85	105	67
Toluene	Yes	50	75	67

(c) identification of molecular ion, (d) identification of important odd-electron ions, (e) study of the general appearance for stability, (f) ranking of possible structural assignments, (g) postulation of molecular structures and a test against a reference spectrum.

(3) Library searches with or without computer assist--usually involves direct or indirect comparison of the unknown to a reference spectrum.

As probable identifications were achieved, a level of confidence value was assigned to each identification. Therefore, the reliability of a given identification may be taken into account when data are evaluated. The three levels of confidence that reflect the degree of certainty of the identifications are:

Level 1: Confirmed identification--mass spectra and GC retention time agree with that obtained with a standard compound under identical conditions.

Level 2: Highly probable identification--good manual concurrence with reference spectrum.

Level 3: Tentative identification--reference spectra either not available or match uncertain due to interferences, low intensity, etc; possibility of misidentification is significant.

B.2 SAMPLING EQUIPMENT CALIBRATION

Routine sampling equipment calibrated prior to testing included: (1) pitot tubes, (2) Magnehelic® pressure gauges, (3) temperature measuring devices, (4) a dry gas meter, and (5) an analytical balance. QC documentation for this equipment is routine and is maintained in the permanent project files.

APPENDIX C

TESTING LOG

Information related to test dates, test time periods, catalyst temperature setpoint, press/incinerator operation, and continuous analysis activities is presented in Tables C-1 and C-2 for incinerators 20 and 21, respectively.

TABLE C-1. TESTING LOG--INCINERATOR 20

Date	Time	Catalyst Temperature Setpoint	Product	Press Status	Incinerator Status	System Operation	Status of EPA Method 25A Analysis
012083	1717-2359	371°C (700°F)	A	On/Off	On/Off	Varied	None (calibration)
012183	0000-0340	371°C (700°F)	A	On/Off	On	Varied	None (calibration)
	0341-0403	371°C (700°F)	A	On/Off	On	Unsteady	Inlet THC, outlet THC
	0404-0439	371°C (700°F)	A	On	On	Steady	Inlet THC, outlet THC
	0440-0628	371°C (700°F)	A	On/Off	On	Unsteady	Inlet THC, outlet THC
	0629-0802	371°C (700°F)	A	On	On	Steady	Inlet THC, outlet THC
	0803-0827	371°C (700°F)	A	On	On	Steady	Inlet THC, outlet FS
	0828-1012	371°C (700°F)	A	On/Off	On	Unsteady	Inlet THC
	1013-1040	371°C (700°F)	A	On	On	Steady	Inlet THC, outlet FS
	1041-1117	371°C (700°F)	A	Off	On	Unsteady	Inlet THC, outlet FS
	1118-1212	371°C (700°F)	A	On	On	Steady	Inlet THC, outlet FS
	1213-1232	371°C (700°F)	A	On	On	Steady	Inlet THC
	1233-1342	371°C (700°F)	A	On	On	Steady	Inlet THC, outlet THC
	1343-1447	371°C (700°F)	A	On/Off	On	Unsteady	Inlet THC, outlet THC
	1448-1523	371°C (700°F)	A	On	On	Steady	Inlet THC
	1524-1554	371°C (700°F)	A	On	On	Steady	Inlet THC, outlet THC
	1555-1625	385°C (725°F)	A	On	On	Steady	Inlet THC, outlet THC
	1626-1645	385°C (725°F)	A	Off	On	Unsteady	Inlet THC, outlet THC
	1646-1813	385°C (725°F)	A	On	On	Steady	Inlet THC, outlet THC
	1814-1830	385°C (725°F)	A	Off	On	Unsteady	Inlet THC, outlet THC
	1831-1956	385°C (725°F)	A	On	On	Steady	Inlet THC, outlet THC
	1957-2043	385°C (725°F)	A	Off	On	Unsteady	Inlet THC, outlet THC
	2044-2139	385°C (725°F)	A	On	On	Steady	Inlet THC, outlet THC
	2140-2158	385°C (725°F)	A	Off	On	Unsteady	Inlet THC, outlet THC
	2159-2210	385°C (725°F)	A	On	On	Steady	Inlet THC, outlet THC
	2210-2217	385°C (725°F)	A	On	On	Steady	Inlet THC
	2218-2359	385°C (725°F)	A	On	On	Steady	Inlet THC, outlet FS
012283	0000-0018	385°C (725°F)	A	On	On	Steady	Inlet THC, Outlet FS
	0019-0028	385°C (725°F)	A	On	On	Steady	Inlet THC, outlet THC
	0029-0053	385°C (725°F)	A	On	On	Steady	Outlet THC
	0054-0543	385°C (725°F)	A	Off/on	On	Varied	None (calibration)
	0544-0652	385°C (725°F)	A	On	On	Unsteady	Inlet THC
	0653-0756	399°C (750°F)	A	On	On	Unsteady	Inlet THC, outlet THC
	0757-0818	399°C (750°F)	A	On	On	Unsteady	Inlet THC
	0819-0907	399°C (750°F)	A	On	On	Unsteady	Inlet THC, outlet FS
	0908-0919	399°C (750°F)	A	Off/On	On	Unsteady	Outlet FS
	0920-1628	399°C (750°F)	A	Off/On	On	Varied	None (instrument maintenance)
	1629-1638	399°C (750°F)	A	On	On	Steady	Outlet THC
	1639-1818	399°C (750°F)	A	On	On	Steady	Inlet THC, outlet THC
	1819-1826	399°C (750°F)	A	On	On	Steady	Inlet THC
	1827-1944	399°C (750°F)	A	On	On	Steady	Inlet THC, outlet THC
	1945-2003	399°C (750°F)	A	Off	On	Unsteady	
	2004-2359	399°C (750°F)	A	Off	?	Unsteady	None (calibration)
012383	0000-1549	399°C (750°F)	A	Off/on	?	Varied	None (calibration)
	1550-2359	399°C (750°F)	A	Off/on	On	Varied	None (QC audit)
012483	0000-0055	399°C (750°F)	A	Off	On	Unsteady	None (audit/calibration)
	0056-0123	399°C (750°F)	A	On	On	Unsteady	Inlet THC, outlet THC
	0124-0214	399°C (750°F)	A	On/off	On	Unsteady	Inlet THC
	0215-0302	399°C (750°F)	A	On/off	On	Unsteady	Inlet THC, outlet FS
	0303-0313	399°C (750°F)	A	Off	On	Unsteady	Inlet THC
	0314-1215	399°C (750°F)	A	On/off	On	Unsteady	Inlet THC, outlet FS

TABLE C-2. TESTING LOG--INCINERATOR 21

Date	Time	Catalyst Temperature Setpoint	Product	Press Status	Incinerator Status	System Operation	Status of EPA Method 25A Analysis
012583	0400-0745	371°C (700°F)	B	On/Off	On	Varied	None (calibration)
	0746-1626	371°C (700°F)	B	On/Off	On	Varied	None (heated sampling line setup)
	1627-1751	371°C (700°F)	B	On	On	Steady	Outlet THC
	1752-2124	371°C (700°F)	B	On	On	Steady	Inlet THC, outlet THC
	2125-2205	371°C (700°F)	B	On/Off	On	Unsteady	Inlet THC, outlet THC
	2206-2245	371°C (700°F)	B	On	On	Steady	Inlet THC, outlet THC
	2246-2256	371°C (700°F)	B	On	On	Steady	Inlet THC
	2257-2345	371°C (700°F)	B	On	On	Steady	Inlet THC, outlet FS
	2346-2359	371°C (700°F)	B	Off	On	Unsteady	Inlet THC, outlet FS
012683	0000-0009	371°C (700°F)	B	Off	On	Unsteady	Inlet THC, outlet FS
	0010-0039	371°C (700°F)	B	On	On	Steady	Inlet THC, outlet FS
	0040-0220	371°C (700°F)	B	On/Off	On	Unsteady	Inlet THC, outlet FS
	0221-0233	371°C (700°F)	C	Off	Off	Unsteady	Inlet THC, outlet FS
	0234-0435	371°C (700°F)	C	Off	Off	Unsteady	None (calibration)
	0436-0542	371°C (700°F)	C	On/Off	On	Unsteady	None (calibration)
	0543-0558	371°C (700°F)	C	On	On	Unsteady	Inlet THC, outlet THC
	0559-0740	371°C (700°F)	C	On	On	Steady	Inlet THC, outlet THC
	0741-0803	371°C (700°F)	C	On	On	Steady	Inlet THC
	0804-0844	371°C (700°F)	C	On/Off	On	Unsteady	Inlet THC, outlet THC
	0845-1207	385°C (725°F)	C	On	On	Steady	Inlet THC, outlet THC
	1208-1240	385°C (725°F)	C	Off	On	Unsteady	Inlet THC, outlet THC
	1241-1338	385°C (725°F)	C	On	On	Steady	Inlet THC, outlet THC
	1339-1355	385°C (725°F)	C	Off	On	Unsteady	Inlet THC, outlet THC
	1356-1430	385°C (725°F)	C	On	On	Steady	Inlet THC, outlet THC
	1431-1705	385°C (725°F)	D	On/Off	On	Unsteady	Inlet THC, outlet THC
	1706-1841	385°C (725°F)	D	On	On	Steady	Inlet THC, outlet THC
	1842-1906	385°C (725°F)	D	On	On	Steady	Inlet THC, outlet FS
	1907-2052	385°C (725°F)	D	On/Off	On	Unsteady	Inlet THC
	2053-2317	385°C (725°F)	D	On	On	Steady	Inlet THC, outlet FS
	2318-2321	385°C (725°F)	D	On	On	Steady	Inlet THC
	2322-2359	385°C (725°F)	D	On	On	Steady	Inlet THC, outlet THC
012783	0000-0019	385°C (725°F)	D	On	On	Steady	Inlet THC, outlet THC
	0020-0034	385°C (725°F)	D	Off	On	Unsteady	Inlet THC, outlet THC
	0035-0358	385°C (725°F)	E	On/Off	?	Varied	Inlet THC, no outlet analysis (calibration)
	0359-0459	399°C (750°F)	E	On	On	Steady	Outlet THC, no inlet analysis (calibration)
	0500-0536	399°C (750°F)	E	On	On	Steady	Inlet THC, outlet THC
	0537-0628	399°C (750°F)	E	Off	On	Unsteady	Inlet THC, outlet THC
	0629-1023	399°C (750°F)	E	On	On	Steady	Inlet THC, outlet THC
	1024-1738	399°C (750°F)	F	On/Off	On/Off	Unsteady	Inlet THC, outlet THC
	1739-1748	399°C (750°F)	F	On/Off	On	Unsteady	Inlet THC
	1749-2033	399°C (750°F)	F	On	On	Unsteady	Inlet THC, outlet FS
	2034-2113	399°C (750°F)	F	On	On	Steady	Inlet THC, outlet FS
	2114-2119	399°C (750°F)	F	On	On		Inlet THC, outlet THC
	2120-2209	399°C (750°F)	F	Off	On	Unsteady	Inlet THC, outlet THC
	2210-2318	399°C (750°F)	F	On	On	Steady	Inlet THC, outlet THC
	2319-2331	399°C (750°F)	F	Off	On	Unsteady	Inlet THC, outlet THC

APPENDIX D

PROBLEMS ENCOUNTERED DURING TESTING

During the course of testing at Plant C-3, certain problems were encountered that impacted the schedule and analysis. These problems and Radian's efforts to define and solve them are detailed in this appendix.

D.1 PROCESS PROBLEMS

The only problem area associated with the process operation was somewhat more press downtime than had been anticipated. With visual observation and the almost instantaneous change in process temperatures, these upsets were easily identified at Plant C-3. Thus, little or no uncertainty in the data resulting from these upsets is anticipated.

D.2 SAMPLING/ANALYTICAL PROBLEMS

Several sampling/analytical problems developed during the course of the testing, including those related to sampling lines, the THC analyzers, and the GC-FID instrument.

D.2.1 Sample Lines

During the first two days on site, a new heated sample manifold system was fabricated. This was necessitated by the relocation of the analytical equipment from a mobile laboratory to the press area. As part of this manifold system, three-way valves were installed to allow both inlet and outlet samples to be analyzed by either the Tracor THC analyzer or the Antek GC-FID. At some point during the early stages of testing, a heat tape shorted and attained a temperature high enough to melt the Teflon® seat in the valve for the Tracor. As a result, the valve failed open, allowing mixing of the inlet and outlet samples. This problem was solved by replacement of the defective heat tape and the three-way valve. Data collected up to the time repairs were affected were not used in the data analysis.

D.2.2 Byron Super 401--THC Analysis

The timing/auto zero sequence for the Byron Super 401 is fixed, allowing a complete THC analysis cycle to be completed in exactly one minute. Details of the events during a cycle are given in Table D-1. Any organic injected into the sample loop must exit through the flame jet within this period, or it will contribute to the next sample analysis.

The heavier and relatively nonvolatile portions of the solvent at Plant C-3 apparently did not completely elute during the one-minute interval. The effect of this "tailing" on the resulting chromatograms is shown schematically in Figure D-1 where the trends are exaggerated to clearly depict the symptoms.

The top diagram shows the effect of a single injection with the analyzer in the spectrum or chromatograph mode. The peak is shown to tail considerably past the one-minute point, but it does eventually return to the baseline.

The middle diagram shows the cumulative effect of multiple injections of a sample with the analyzer in the spectrum mode. All peaks are identical but the pronounced tailing produces the rising baseline shift.

The lower diagram shows the normal operating mode of the Byron Super 401. With the unit in the bar graph mode, the built-in integrator is cleared and the output signal is zeroed at 18 seconds into the cycle. From 18 through 42 seconds, the signal is directed through the attenuators and calibration potentiometers into the integrator for accumulation of area counts. Negative voltages (areas) are ignored.

TABLE D-1. TIMING SEQUENCE OF BYRON SUPER 401

Time (sec)	Instrument Function	Conditions for Modification
0	Cycle begins	
12	Sample inject actuate	
18	Completion of auto zero.	Auto zero only occurs in Bar Graph Mode.
18	Begin THC area accumulation.	
42	Stop THC area accumulation.	
42	Deactuate sample inject.	
60	Reset cycle timer to 0.	

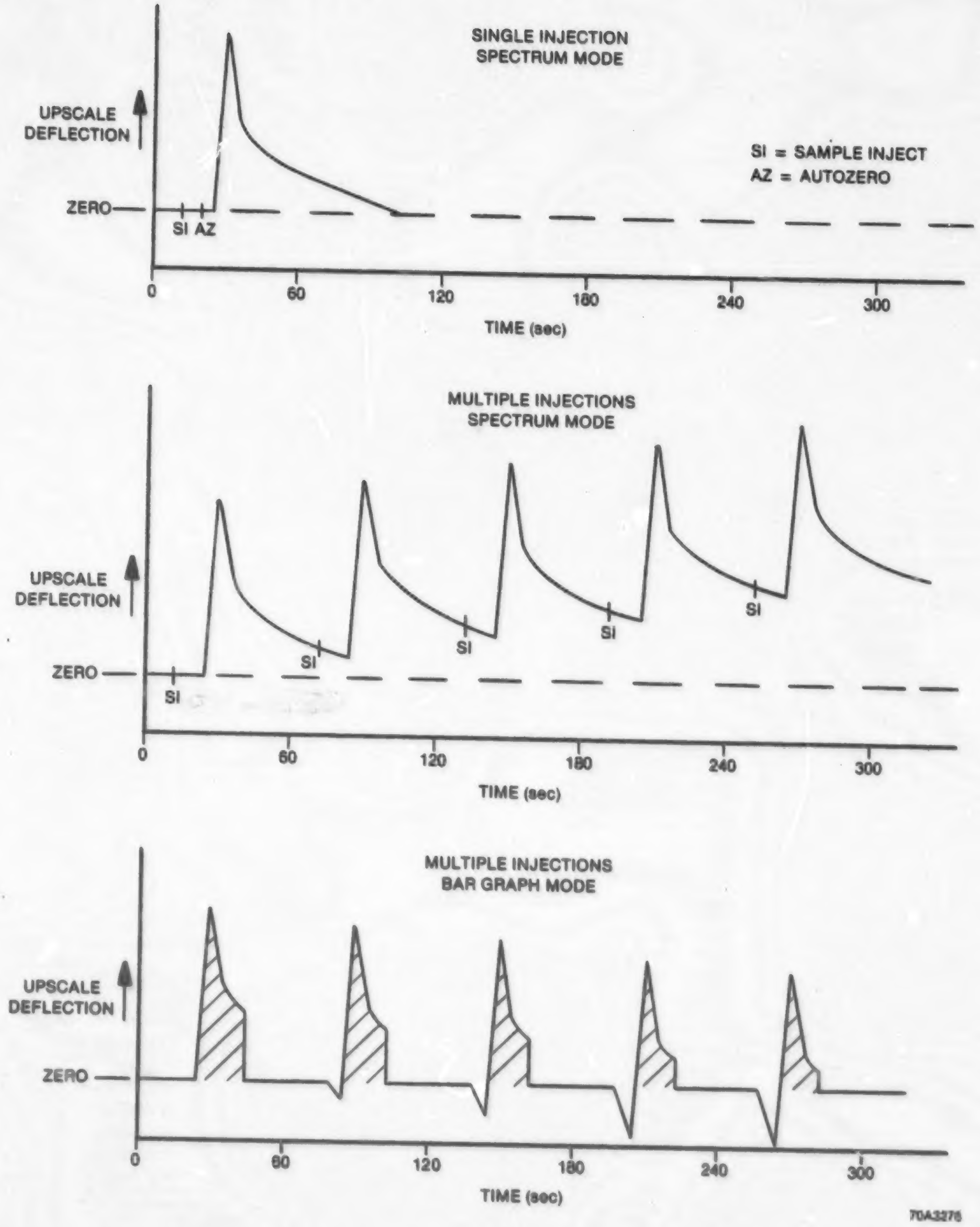


Figure D-1. Chromatograms Obtained When Sample Does Not Completely Elute During 1-Minute Cycle Time

In the first sample of the lower diagram, the area is shown to be low because the tailing area is cut off. In the second sample, the area will be even lower since the tail of the first sample moves the signal below baseline as soon as area collection begins. Additionally, the tail of this second peak is cut off. With succeeding samples, this effect becomes even more pronounced.

During the field testing, attempts were made to quantify this error but these were unsuccessful. After a period of 10 to 15 minutes, the offset did stabilize as evidenced by relatively constant area values. However, the signal continued to drift below the baseline at the beginning of each peak.

D.2.3 Byron Super 401--CO Analysis

The molecular sieve column used to separate CO from CH_4 in the Byron Super 401 did not provide well-defined separation. As mentioned in Appendix B, a mixed gas standard was analyzed daily to ensure optimum performance. Midway through the testing at Plant C-3, the instrument carrier flow was adjusted to provide better integration of both the CH_4 and CO peaks. However, a true improvement in the separation can be affected only by reconditioning or replacing the column. Attempts to improve instrument performance by reconditioning efforts were unsuccessful, suggesting that column replacement is warranted.

D.2.4 Antek GC-FID VOC Speciation

The organic compounds present in the incinerator gases at Plant C-3 consisted of high molecular weight compounds (nominally C_{12} to C_{18} hydrocarbons). In order to prevent condensation of these heavy compounds, the sampling lines and manifold were heated to temperatures as high as 145°C (293°F). Consequently, it was necessary to start the GC oven temperature program at 150°C (302°F). Selection of a single chromatographic column to provide adequate separation of the heavier compounds as well as the C_1 -C_6

calibration compounds at these high oven temperatures was not possible. Therefore, a column was chosen to optimize the separation of the heavier compounds. However, the use of this column resulted in coelution of C_1 through C_4 compounds and poor separation of these from C_5 and C_6 compounds.

APPENDIX E

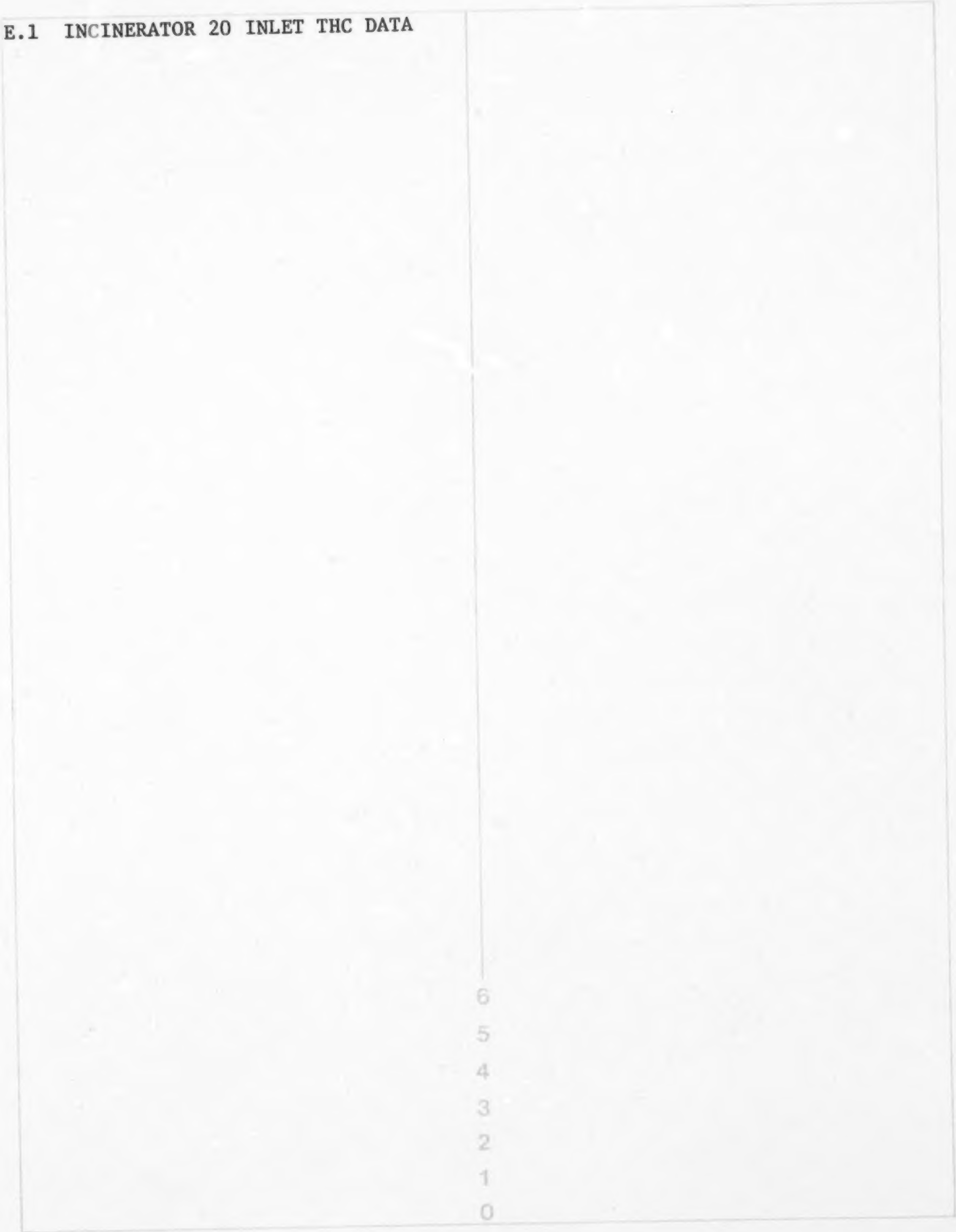
LISTING OF EPA PROPOSED REFERENCE METHOD 25A DATA

Listings of the EPA Proposed Reference Method 25A data for incinerators 20 and 21 are provided in this appendix, as follows:

- incinerator 20 inlet THC data (Section E.1),
- incinerator 20 outlet THC data (Section E.2),
- incinerator 21 inlet THC data (Section E.3), and
- incinerator 21 outlet THC data (Section E.4).

Certain portions of the outlet THC data are presented in Appendix H with the full scan (FS) data.

E.1 INCINERATOR 20 INLET THC DATA



```
CATALYTIC INCINERATOR PROGRAM          PLANT NO 4                   RF=717
 THC CONCENTRATIONS AS C1 IN  INLET (INC#20)  STARTING AT 01/21 03;20
-----------------------------------------------------------------------------


03;20          82    370    125    755     73    161     85    136    891    217

AVERAGE CONC = 289.5 PPM AS C1 FOR  40 MINUTES
-----------------------------------------------------------------------------


04;04         224    951   1011   1028   1033   1080   1256   1089   1122   1091
04;44          82     74     75    593    104    118     81     74     67    355
05;24          80     73     87    112     75    293

AVERAGE CONC = 470.3 PPM AS C1 FOR  104 MINUTES
-----------------------------------------------------------------------------


05;48         267     84     79    700    789    789   1056    419    160    107
06;28         650   1014   1098   1218   1220   1227   1223   1209   1188

AVERAGE CONC = 763.0 PPM AS C1 FOR  76 MINUTES
-----------------------------------------------------------------------------


07;08        1200   1276   1212   1189   1216   1196   1187   1202   1208   1191
07;48        1221   1202

AVERAGE CONC = 1208. PPM AS C1 FOR  48 MINUTES
-----------------------------------------------------------------------------


07;56        1204   1201   1198   1226   1232   1215   1225   1248   1230   1238
08;36        1248   1251   1229   1220   1226   1459   1221   1229   1274   1267
09;16        1254   1239   1214   1257   1243

AVERAGE CONC = 1241. PPM AS C1 FOR  100 MINUTES
-----------------------------------------------------------------------------


09;44        1185   1176    133     82     88    239    106     84    906   1202
10;24        1231   1220   1225   1259   1267    110     70     67     73     69
11;04          71     72    100     63    671   1185   1232   1300   1255   1323
11;44        1306   1305   1318

AVERAGE CONC = 696.6 PPM AS C1 FOR  132 MINUTES
-----------------------------------------------------------------------------


12;00        1278   1227   1296   1281   1263   1296   1318   1316   1291   1312
12;40        1306   1296   1379   1385   1306   1331   1366   1348

AVERAGE CONC = 1310. PPM AS C1 FOR  72 MINUTES
-----------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM               PLANT NO 4                          RF=717
 THC CONCENTRATIONS AS C1 IN  INLET (INC#20)  STARTING AT 01/21 13;20
------------------------------------------------------------------------------------------


13;20         1327      2527      1342      1299      1302      1275      1270        85        79        85
14;00           80       133      1145        85        81

AVERAGE CONC = 807.5 PPM AS C1 FOR  60 MINUTES
------------------------------------------------------------------------------------------


14;20           74        68        63        60        59        62        64        66       906      1213
15;00         1395      1501      1495      1514      1513      1461      1511

AVERAGE CONC = 766.1 PPM AS C1 FOR  68 MINUTES
------------------------------------------------------------------------------------------


16;00         1481      1443      1395      1377      1422      1416      1429      1406        80        97
16;40           76        79       812      1275      1411      1422      1484      1500      1482      1496
17;20         1505      1478      1509      1436      1460      1475      1511      1504      1495      1488
18;00         1505      1524      1513

AVERAGE CONC = 1272. PPM AS C1 FOR  132 MINUTES
------------------------------------------------------------------------------------------


18;14         1115        92        79       158        86      1328      1445      1474      1504      1523
18;54         1566      1550      1522      1555      1549      1594      1534      1576      1617      1597
19;34         1600      1638      1570      1579      1606      1555       163

AVERAGE CONC = 1265. PPM AS C1 FOR  108 MINUTES
------------------------------------------------------------------------------------------


20;02          106       104       115       181       245       280       303       154        78        87
20;42           78       776      1245      1566      1650      1751      1766      1677      1691      1644
21;22         1636      1631      1621

AVERAGE CONC = 886.3 PPM AS C1 FOR  92 MINUTES
------------------------------------------------------------------------------------------


21;34         1640      1698       160       112       246       104        94      1128      1525      1604
22;14         1572      1589      1623      1561      1557      1559      1560      1568

AVERAGE CONC = 1161. PPM AS C1 FOR  72 MINUTES
------------------------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM             PLANT NO 4                    RF=717
NMHC CONCENTRATIONS AS C1 IN  INLET (INC#20)  STARTING AT 01/21 22;44
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------


22;44        1569   1608   1592   1542   1558   1588   1581   1576   1529   1593
23;24        1617   1620   1576   1568   1624   1622   1595   1734   1872   1613
00;04        1614   1623   1655   1619   1611   1618   1586

AVERAGE CONC = 1611. PPM AS C1 FOR  108 MINUTES
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------


05;47         366    360

AVERAGE CONC = 363.0 PPM AS C1 FOR  8 MINUTES
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------


05;55         363    365    364    366    366    351    365    370    369    946
06;35         386    374    366    378    358

AVERAGE CONC = 405.8 PPM AS C1 FOR  60 MINUTES
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------


06;56         364    340    354    608    365    381    350    360    351    347
07;36         358    350    358    363    362    378    370    361    358    358
08;16         358    364    365    249    367    368    367    358    374    369
08;56         352    373    377    377

AVERAGE CONC = 366.2 PPM AS C1 FOR  136 MINUTES
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------


16;42        1275   1519   1801

AVERAGE CONC = 1531. PPM AS C1 FOR  12 MINUTES
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------


16;58        1831   1731   1706   1719   1700   1609   1627

AVERAGE CONC = 1703. PPM AS C1 FOR  28 MINUTES
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------


17;30        1688   1633   1657   1684   1621   1611   4091   1637   1590   1595
18;10        1604   1597   1600   1605   1604   1606   1601   1607   1559   1619
18;50        1627   1633   1654   1601   1617   1642   1591   1605   1568   1607
19;30        1690   1675   1652   1655    181    115    104     92    102     98
20;10          98

AVERAGE CONC = 1424. PPM AS C1 FOR  164 MINUTES
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM          PLANT NO 4                         RF=750
 THC CONCENTRATIONS AS C1 IN  INLET (INC#20)  STARTING AT 01/24 01;00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------


01;00         326    344    344    344    360

AVERAGE CONC = 343.5 PPM AS C1 FOR  20 MINUTES
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------


01;20         369    316     55     49     90     55     52     60    141     49
02;00          47     45     38    874    386    349     46     43     40     40
02;40          40     41     42     41     41

AVERAGE CONC = 133.9 PPM AS C1 FOR  100 MINUTES
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------


03;09          38     35     32     30     74     38    369    350    359    341
03;49         342    351    354    351    352    367    368    364    358    362
04;29         366    364    362    364    354    371    353    359    360    355
05;09         564    359    356    360     57     47     48     56     56     54
05;49          56    372    384    382    353    359    358    361    352     45
06;29          44     43     41     40     38     34     40     40     40     40
07;09          58     50     42    160    372    351     40     42     43     43
07;49          43     41     41     41     40     40     40     40     40     40
08;29          40     40     40     40     40     40     40     40     40     40
09;09          40     40     40     40     40     40     40     40     40     40
09;49          40     40     40     40     40     40     40     40     40     40
10;33          40     40     40     40    320    347    160    240    320    333
11;13         360    387     40     40     40     40     40     40     40     40
11;53          40     40     40     40     40     40

AVERAGE CONC = 148.6 PPM AS C1 FOR  544 MINUTES
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
```

E.2 INCINERATOR 20 OUTLET THC DATA

```
CATALYTIC INCINERATOR PROGRAM          PLANT NO 4        ATTN=500 MULT=5.600
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/20 01;50
-------------------------------------------------------------------------------

01;50        198     189     178     169     198     178     189     169     189     165
02;00        189     169     178     178     189     189     178     189     178     198
02;10        189     204     204     198     198      40      33      33      33      33
02;20         33      33      33      33      40      33      40      40      33      33
02;30         33      48      33      40      33      33      40      40      33  OVRNGE
02;40        217     169     163     169     169     163     163     169     178     163
02;50        187     178     178     187      33      33      33      33      33      33
03;00         33      33      33      33      33      33      33      33      33      33
03;10         33      48      48      33      48      33      40      48      40      33
03;20         33      33     553      40     393     228     189     189     178     189
03;30        178     189     189     178     178     178     198     189     202     211
03;40        198     202     189     198     213     189     213     211     198     213
03;50        213     202     202     202     202     202     213     198  OVRNGE     213
04;00        202     198     220     202     202     202     213     213     213     213
04;10        213     220     220     213     202     220     202     220     202     220
04;20        202     202     211     198     198     202     213     220     220     220
04;30        198     213     220     213     211     189     202     202     198     211
04;40        189     189     211      88      33      48      48      40      33      40
04;50         40      40      33      33      40      40      40      40      33      33
05;00         40      40      33      33      33      40      33      33      35      35
05;10         26      35      40      37      33      37      35      33      33      37
05;20         40      33      40      40      33      59     321     329     163     226
05;30        253     226     226     226     233     226     233     226     226     253
05;40        226     233     242     242     226     242     233     242     242     242
05;50        242     233     242     253     242     253     242     242     253     253
06;00        233     233     253     261     261     261     332     242     242     253
06;10        242     253     253     261     253     261     261     253     277     268
06;20        283     261     261     253     261     277     261     253     268     268
06;30        244     264     244     253     264     242     268     253     261     268
06;40        253     250     253     253     235     253     242     253     244     255
06;50     OVRNGE     294     264     264     253    '253     239     198     233     242
07;00        222     165     187     220     244     195     235     228     244     217
07;10        204     228     202     239     235     233     253      88      48      53
07;20         40      48      48      48      59      59      40      40      40      48
07;30         40      40      40      40      48      48      59      48      48      48
07;40         59      48      48      48      40      48      40      40      40      48
07;50         40      40      48      40      48      48      59      48      48      48
08;00         59      48      48      59      59      59      48      59      48      59
08;10         48      48      48      48      40      48      40      48      48      48
08;20         40      68      68      48      59      68      68      48      68      59
08;30         48      59      59      59      57      59      48      59      59      48
08;40         40      40      33      40      48      40      40      48      40      40
08;50         40      40      40      40      40      40      40      40      40      40
09;00         40      48      40      40      33      33      48      40      33      40
09;10         33      40      33      40      40      40      33      33      33      33
09;20         40     332     332     244      40      33      40      48      33

AVERAGE CONC = 133.2 PPM AS C1 FOR  459 MINUTES   (3 OVERANGED POINTS);
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CATALYTIC INCINERATOR PROGRAM          PLANT NO 4         ATTN=500 MULT=5.600
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/20 09;37
--------------------------------------------------------------------------------

09;37         40      40      40      33      33     114     264      83     332     332
09;47         24     268     235     233     244     235     235     235     228     244
09;57        244     235     244     264     244     264     253     264     253     253
10;07        233     253     264     253     253     264     253     253     253

AVERAGE CONC = 212.2 PPM AS C1 FOR  39 MINUTES
--------------------------------------------------------------------------------

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```
CATALYTIC INCINERATOR PROGRAM          PLANT NO 4          ATTN=500 MULT=5.600
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/20 13;59
------------------------------------------------------------------------------


13;59         318    228    198    189    204    204    228    235    244    228
14;09         220    228    220    235    220    228    235    213    220    228
14;19         228    220    213    228    220    235    220    228    235    228
14;29         459    439    430    318    279    253    244    459    408     90
14;39          33     24     24     24     33     24     24     24     24     24
14;49          33     24     33     33     24     33     33    165    154    154
14;59          59     48     33     33     33     24     24     24     33     24
15;09          24     33    132    389    228    253    244    244    228    228
15;19         220    220    235    235    228    228    228    235    213    235
15;29         228    220    228    228    228    235    220    228    220    220
15;39         220    228    228    228    213    220    213    213    220    220
15;49         220    235    220    228    235    228    235    228    235    228
15;59         235    235    220    228    220    228    228    228    228    228
16;09          48     24     24     24     24    430    494    163    387    268
16;19         261    268    242    242    253    233    244    242    242    228
16;29         220    228    211    211    211    220    211    233    228    233
16;39         228    213    235    228    213    228    235    235    228    220
16;49         220    220    228    228    228    228    244    228    233    228
16;59         228    228    228    228    220    220    228    235    222    220
17;09         220    228    220    228    235    228    235    228

AVERAGE CONC = 201.5 PPM AS C1 FOR  198 MINUTES
------------------------------------------------------------------------------

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```
CATALYTIC INCINERATOR PROGRAM        PLANT NO 4       ATTN=500 MULT=5.393
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/21 03;41
----------------------------------------------------------------------------


03;41        55        63        47        32        23        32        32        55       345       296
03;51       205       205       203       214       195        49        23        25        30        25
04;01        30        25        99       324       197       292       264       258       256       239
04;11       224       228       243       241       224       224       226       237       243       243
04;21       243       243       241       237       241       237       245       258       252       241
04;31       235       224       243       224       224       224       233    OVRNGE       431       258
04;41       218        32        32        38        38        32        38        38        32        38
04;51        38        32        38        32    OVRNGE       469       408       125        55        59
05;01       315       321       171        38        32        38        38        38        47        47
05;11        38        38        38        38        32        38        32        32        38       345
05;21        23        32        47        32        47        38        38        32        38        47
05;31        32        38        38        38       133        85        32        38        38        38
05;41        32        38        47    OVRNGE        70        47        55       108        70        47
05;51        38        47        38        38        47        47        38        38        38        38
06;01       330       118       127       455       315       296       171       195       258       266
06;11       266       258       252       252       235        47        47        38        55        47
06;21        55        55        63        47        55        47        47       349       461       148
06;31       351        55       273       273       266       258       266       266       258       258
06;41       252       258       266       252       252       258       266       243       228       211
06;51       220       254       243       235       254       235       243       254       243       254
07;01       243       258       243       235       243       254       235       243       254       235
07;11       235       315       336       235       235       243       235       243       243       235
07;21       243       235       224       243       243       243       243       235       224       269
07;31       224       235       243       243       235       224       224       224       224       224
07;41       233       209       205       211       218       209       216       224       220       235
07;51       235       224       254       226       235       235       224       235

 AVERAGE CONC = 166.9 PPM AS C1 FOR  258 MINUTES   (3 OVERANGED POINTS);

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```

```
CATALYTIC INCINERATOR PROGRAM        PLANT NO 4        ATTN=500 MULT=5.393
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/21 12;34
--------------------------------------------------------------------------


12;34          269    254    226    235    235    245    245    235    434    245
12;44          243    235    235    254    245    245    245    254    269    254
12;54          245    235    245    254    235    235    226    243    245    254
13;04          245    235    235    235    260    254    235    245    260    245
13;14          254    235    254    254    226    254    254    254    245    505
13;24          408    408    245    245    254    243    254    245    245    245
13;34          245    245    235    235    235    235    243    245    245    235
13;44           23     23     23     23     23     23     23     23     23     23
13;54           23     23     23     23     23     23     23     23     23     23
14;04           23     23     23    254    220     38     23     23     32     32
14;14           23     38     32     32     32     38     38     23     32     38
14;24           32     23     32     32     32     23     32     32     38     32
14;34           32     23     32     32     23     23     32     23     32     38
14;44           32     32     23     32     38    269    330    235    269    260
14;54          254    254    258    226

AVERAGE CONC = 156.0 PPM AS C1 FOR  144 MINUTES
--------------------------------------------------------------------------


15;25          258    254    243    260    254    254    235    243    243    254
15;35          243    254    243    243    254    254    243    254    243    243
15;45          235    235    235    245    243    243    243    235    243    254

AVERAGE CONC = 246.0 PPM AS C1 FOR  30 MINUTES
--------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM        PLANT NO 4        ATTN=500 MULT=5.393
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/21 15;55
--------------------------------------------------------------------------------

15;55          254    243    269    254    254    226    235    226    226    235
16;05          245    235    226    226    235    226    226    220    226    235
16;15          226    235    235    243    235    226    235    235    226    243
16;25          235    235    235     99     23     23     23     32     23     23
16;35           38     32     23     38     32     38     32     32     23     38
16;45           32     32     32     32     23     57    273    254    258    254
16;55          254    235    235    243    243    235    235    243    235    254
17;05          243    235    243    235    243    235    235    235    243    235
17;15          235    235    235    243    235    226    226    235    226    235
17;25          235    226    226    235    235    235    235    243    235    243
17;35          235    226    254    235    243    243    226    220    226    235
17;45          243    235    226    235    243    243    226    226    235    235
17;55          235    226    226    226    235    243    243    226    226    235
18;05          226    243    235    254    235    226    243    254    220    243
18;15          133     23     32     23     32     32     32     32     23     32
18;25           47     57     55     32     23     32     47    220    254    254
18;35          254    245    245    245    235    235    224    224    233    224
18;45          233    233    224    235    243    235    235    245    245    245
18;55          245    245    254    235    226    245    254    226    235    245
19;05          245    245    235    245    245    245    254    254    254    254
19;15          245    245    235    245    235    235    226    243    245    243
19;25          243    233    243    258    243    252    258    254    250    258
19;35          250    252    254    235    245    260    245    235    235    254
19;45          245    260    254    254    235    254    258    243    243    243
19;55          243    243    118     38     32     32     32     38     47     38
20;05           32     38     38     44     44     38     38     32     47     38
20;15           47     47     38     38     38     47     87     47     57     38
20;25           44     57     38     47     38     47     38     47     47     47
20;35           47     38     38     32     32     32     47     32     32     32
20;45          173    283    245    254    245    254    243    233    233    233
20;55          243    235    235    254    245    235    245    254    254    260
21;05          245    245    245    245    226    243    243    243    243    233
21;15          243    233    243    235    239    245    235    245    235    245
21;25          243    243    243    243    243    243    370    254    254    258
21;35          243    254    254    258    243    252     32     32     32     32
21;45           32     38     38     32     38     57     47     38     38     32
21;55           32     32     38     38     47    245    283    226    260    245
22;05          245    245    254    254    226

 AVERAGE CONC = 183.4 PPM AS C1 FOR  375 MINUTES
 -------------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM         PLANT NO 4        ATTN=500 MULT=5.393
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/22 00;21
-----------------------------------------------------------------------------

00;21          258     226     235     226     211     226 OVRNGE OVRNGE     423     298
00;31          220     220     235     235     243     235     235     235     243     235
00;41          226     243     235     235     243     235     226     235     226     235
00;51          226     226     220

AVERAGE CONC = 225.7 PPM AS C1 FOR  33 MINUTES   (2 OVERANGED POINTS);

-----------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM        PLANT NO 4        ATTN=500 MULT=5.348
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/22 06;55
------------------------------------------------------------------------------


06;55          84      94      80      80      80      80      80      80      69      84
07;05          80      80      94      80     499     344     170     271     147      99
07;15          94      94      94      94      94      86      99      94      94      94
07;25          94      94      86      94      86      86      99      94      94      86
07;35          80      80      80      80      80      78      80      80      69      69
07;45          80      86      80      86      86      86      86      86      94      86

AVERAGE CONC = 102.5 PPM AS C1 FOR  60 MINUTES
------------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM         PLANT NO 4        ATTN=500 MULT=5.348
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/22 16;42
-----------------------------------------------------------------------------

16;42        216    216    231    241    222    222    222    216    231    231
16;52        231    231    231    222    216    216    231    216    216    216
17;02        208    222    222    208    222    216    208    201    201    208
17;12        222    216    208    250    216    208    208    201    208    231
17;22        208    394    409    256    222    241    216    241    222    231
17;32        222    231    222    231    216    216    222    231    222    222
17;42        216    222    222    222    222    231    216    216    222    231
17;52        216    208 OVRNGE     21 OVRNGE    241    222    222    222    222
18;02        216    222    231    222    216    231    222    216    216    231
18;12        208    222    208    201    208    208    201

AVERAGE CONC = 217.5 PPM AS C1 FOR  97 MINUTES   (2 OVERANGED POINTS);
-----------------------------------------------------------------------------

18;28        231    222    216    208    216    208    222    208    216    208
18;38        201    216    193    208    201    216    201    201    216    216
18;48        208    216    222    208    216    222    222    222    216    216
18;58        222    208    208    216    208    208    216    208    208    208
19;08        201    201    491 OVRNGE    503    241    222    216    216    208
19;18        216    222    216    208    208    208    216    208    208    241
19;28        216    241    222    222    222    222    216    216    216    222
19;38        208    208    208    222    216    216     31     31     36     31
19;48         31     31     31     36     31     36     31     31     36     31
19;58         31     31     31     31     31     31

AVERAGE CONC = 180.0 PPM AS C1 FOR  96 MINUTES   (1 OVERANGED POINTS);
-----------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM          PLANT NO 4         ATTN=500 MULT=5.348
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/24 00;57
------------------------------------------------------------------------------

00;57        132     189     170     147     132     117     117      99      99      99
01;07         99      94      94      94      99      94      99      94      99      94
01;17         94      94      99      99      99      94      94

AVERAGE CONC = 108.6 PPM AS C1 FOR  27 MINUTES
------------------------------------------------------------------------------
```

E.3 INCINERATOR 21 INLET THC DATA

```
                                                                          RF=740
CATALYTIC INCINERATOR PROGRAM            PLANT NO 5
 THC CONCENTRATIONS AS C1 IN   INLET (INC#21)   STARTING AT 01/25 17;52
--------------------------------------------------------------------------------


17;52       4797

AVERAGE CONC = 4797 PPM AS C1 FOR  4 MINUTES
--------------------------------------------------------------------------------


17;56       4606

AVERAGE CONC = 4606 PPM AS C1 FOR  4 MINUTES
--------------------------------------------------------------------------------


18;00       4399   4234   4112

AVERAGE CONC = 4248. PPM AS C1 FOR  12 MINUTES
--------------------------------------------------------------------------------


18;12       4030   4030   4010   4001   2474   3890   3954   3915

AVERAGE CONC = 3788 PPM AS C1 FOR  32 MINUTES
--------------------------------------------------------------------------------


18;44       3914   3873   3912   3852   3888   3919   3973   3952   3961

AVERAGE CONC = 3916 PPM AS C1 FOR  36 MINUTES
--------------------------------------------------------------------------------


19;24       4044   4088   4065   4084   4146   4065   4105   4102   4114   4136
20;04       4185   4094   4107   4080   4131   4084   4148   4065   4028

AVERAGE CONC = 4098. PPM AS C1 FOR  76 MINUTES
--------------------------------------------------------------------------------


20;44       4064   4233   4053   3859   3820   3873   3939   3924   4032   3984
21;24        616    147    992    475   3805   3901    589    129    101     92
22;04        533    158   3572   3870   4056   4098

AVERAGE CONC = 2573. PPM AS C1 FOR  104 MINUTES
--------------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM        PLANT NO 5                  RF=740
NMHC CONCENTRATIONS AS C1 IN  INLET (INC#21)  STARTING AT 01/25 22;28
--------------------------------------------------------------------------------


22;28       4157   4076   4064   3966   3994   4006   4092   4053   4030   4007
23;08       4055   4080   4068   4144   4142   4166   4163   4101   4331   4250
23;48        702    178    137    635    433    132

AVERAGE CONC = 3236. PPM AS C1 FOR  104 MINUTES
--------------------------------------------------------------------------------


00;12       2254   4041   4287   4350   4399   4425   4363    416    181    330
00;52        403    107     85

AVERAGE CONC = 2279. PPM AS C1 FOR  52 MINUTES
--------------------------------------------------------------------------------


01;04         79     82     84     76     64     60     61     69     66     66
01;44         63     62     60     53     54   2786   3214   3657   4036   4268
02;24        690    365

AVERAGE CONC = 909.8 PPM AS C1 FOR  88 MINUTES
--------------------------------------------------------------------------------


05;46        700    798    953   1035   1292   1378

AVERAGE CONC = 1025. PPM AS C1 FOR  24 MINUTES
--------------------------------------------------------------------------------


06;10       1350   1375   1378   1404   1320   1329   1413   1370   1346   1226
06;50       1249   1349   1366   1363   1381   1387   1391

AVERAGE CONC = 1352. PPM AS C1 FOR  68 MINUTES
--------------------------------------------------------------------------------


07;18       1382   1418   1403   1386   1411   1484   1441   1475   1449   1466
07;58       1496   1481    129     76     89     87     75

AVERAGE CONC = 1044. PPM AS C1 FOR  68 MINUTES
--------------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM       PLANT NO 5                     RF=729
NMHC CONCENTRATIONS AS C1 IN  INLET (INC#21)  STARTING AT 01/26 08;30
------------------------------------------------------------------------------


08;30        62     71     73     64    913   1511   1621

AVERAGE CONC = 616.6 PPM AS C1 FOR  28 MINUTES
------------------------------------------------------------------------------


08;58      1670

AVERAGE CONC = 1670 PPM AS C1 FOR  4 MINUTES
------------------------------------------------------------------------------


09;02      1654   1665   1564   1628   1603   1615   1595   1578   1598   1618
09;42      1630   1626   1659   1605   1597   1582   1590   1607   1657   1656
10;22      1641   1658   1647   1679   1655   1653   1632   1988   1717   1633
11;02      1655   1659   1619   1648   1652   1629   1636   1665   1632   1654
11;42      1665   1687   1703   1715   1669   1692   1743    101     66     72
12;22        73     69    147     74     73    559   1718   1845   1809   1814
13;02      1806   1823   1798   1806   1838   1781   1756   1779   1779   1770
13;42        81    122     66    148   1663   1842   1824   1807   1801   1827
14;22      1760

AVERAGE CONC = 1442. PPM AS C1 FOR  324 MINUTES
------------------------------------------------------------------------------


18;44      1734   1758   1758   2418   1614   1692   1722   1717   1732   1713
19;24      1693    118     66     58     50     52    636    286     62    681
20;04      1672   1733   1736   1777   1768   1781   1813   1781   1803   1804
20;44      1773   1798   1764   1741   1716   2323   1713   1666   1706   1703
21;24      1688   1716   1754   1779   1766   1789   1796   1802   1945   1948
22;04      2019   2104   2152   2142   2203   2137   2181   2073   2080   2130
22;44      2122   2061   2098   2103

AVERAGE CONC = 1636. PPM AS C1 FOR  256 MINUTES
------------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM        PLANT NO 5                    RF=729
 THC CONCENTRATIONS AS C1 IN  INLET (INC#21)  STARTING AT 01/26 21:24
------------------------------------------------------------------------

21;24        1688   1716   1754   1779   1766   1789   1796   1802   1945   1948
22;04        2019   2104   2152   2142   2203   2137   2181   2073   2080   2130
22;44        2122   2061   2098   2103   2104   2115   2099   2084   2086   2082
23;24        2107

AVERAGE CONC = 2008. PPM AS C1 FOR  124 MINUTES
------------------------------------------------------------------------


23;28        2101   2099   2104   2090   2114   2120   2164   2156   2132

AVERAGE CONC = 2120 PPM AS C1 FOR  36 MINUTES
------------------------------------------------------------------------


00;21        2201   198    88

AVERAGE CONC = 828.7 PPM AS C1 FOR  12 MINUTES
------------------------------------------------------------------------


CATALYTIC INCINERATOR PROGRAM        PLANT NO 5                    RF=775
 THC CONCENTRATIONS AS C1 IN  INLET (INC#21)  STARTING AT 01/27 05;10
------------------------------------------------------------------------

05;10        2013   2392   2673

AVERAGE CONC = 2359. PPM AS C1 FOR  12 MINUTES
------------------------------------------------------------------------


05;22        2829   2917   2902   2873

AVERAGE CONC = 2880. PPM AS C1 FOR  16 MINUTES
------------------------------------------------------------------------


05;38        2786

AVERAGE CONC = 2786 PPM AS C1 FOR  4 MINUTES
------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM          PLANT NO 5                     RF=775
NMHC CONCENTRATIONS AS C1 IN  INLET (INC#21)  STARTING AT 01/27 05;50
------------------------------------------------------------------------------


05;50   '    94
AVERAGE CONC = 94.04 PPM AS C1 FOR  4 MINUTES
------------------------------------------------------------------------------


05:54        67     64     53     53     49     65     54    127     66     62
06;34      2056   2432   2686   2904   2920   2908   2838   2842
AVERAGE CONC = 1235. PPM AS C1 FOR  72 MINUTES
------------------------------------------------------------------------------


07;06      2834   2785   2696   2753   2758   2771   2693   2661   2634   2664
07;46      2705   2342   2593   2641   2661   2684   2701   2697   2689   2694
08;26      2655   2687   2681   2692   2664   2672   3126   3285   3260   3325
09;06      3279   3324   3296   3277   3308   3343   3227   3232   3285   3293
09;50      3276   3320   3366   3277   3335   3327   3354   3323   3327   3328
10;30       366    219     80     70     81     75     63     58     54     53
11;10        52     52     49     46     45     44     43     45     47     44
11:50        47     45     43     44     52     45     61     44     59     64
12;30        62     50
AVERAGE CONC = 1841. PPM AS C1 FOR  328 MINUTES
------------------------------------------------------------------------------


12;58        55     48     41     46     52     57     63    629    746   1051
13;38      1023   1090   1081   1091    216    611    389     59     60     54
14;18        49     45     44     43     44     43     44     44     45     40
14;58        38
AVERAGE CONC = 288.3 PPM AS C1 FOR  124 MINUTES
------------------------------------------------------------------------------


15;10        36    450    737    812    948    830   1123   1137   1150   1115
15;50      1121   1111   1090   1134   1135   1166   1148    139    508    507
16;30        99     65     57     51     50
AVERAGE CONC = 708.7 PPM AS C1 FOR  100 MINUTES
```

```
                                                                       RF=775
CATALYTIC INCINERATOR PROGRAM           PLANT NO 5
 THC CONCENTRATIONS AS C1 IN  INLET (INC#21)  STARTING AT 01/27 16;50
--------------------------------------------------------------------------------


16;50         51     46     45     44     44     42     40     43     43     39
17;30         44     42     44     46    512    986   1112   1359    518   1321
18;10       1425   1537   1540   1649   1677   1670   1590   1608   1860   1901
18;50       1918   1964   1964   1999   2011   1992   2009   2024   2005   2044
19;30       2038   2048   2006   2043   2058   2075   2104   2149

AVERAGE CONC = 1236. PPM AS C1 FOR  192 MINUTES
--------------------------------------------------------------------------------


20;04       2124   2100   2093   2079   2105   2125   2097   2308   1973   2069
20;44       2070   2046   2108   2114   2090   1959   1986   2042   1997   2140
21;24        271    101    325    175    112    136     91     80     71     69
22;04         74     74   1408   1814   2012   2159   2156   2188

AVERAGE CONC = 1445. PPM AS C1 FOR  152 MINUTES
--------------------------------------------------------------------------------


22;52       2157   2183   2209   2194   2189   2232   2171   2181    192     92
23;32         65

AVERAGE CONC = 1624. PPM AS C1 FOR  44 MINUTES
--------------------------------------------------------------------------------
```

E.4 INCINERATOR 21 OUTLET THC DATA

```
CATALYTIC INCINERATOR PROGRAM         PLANT NO 5        ATTN=500 MULT=5.023
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/25 16;28
---------------------------------------------------------------------------

16:28        160   146   146   152   138   146   152   169   160   152
16;38        146   146   138   146   138   152   138   152   152   146
16;48        146   138   146   160   152   160   152   160   160   160
16;58        152   160   169   160   152   152   160   152   152   152
17;08        160   169   169   152   160   169   160   160   160   152
17;18        169   160   152   160   152   160   160   146   152   169
17;28        160   152   160   152   152   160   160   160   160   169
17;38        146   152   160   152   152   152   152   160   160   152
17;48        152   160   160   169   169   152   146   152   152   152
17;58        160   160   152   160   152   169   169   160   169   177
18;08        177   160   169   160   160   169   146   160   152   160
18;18        177   167   167   160   169   152   160   169   262   234
18;28        118    93   195   189   146   132   138   146   152   160
18;38        181   181   181   189   189   152   160   146   152   160
18;48        167   177   177   160   167   152   152   152   152   162
18;58        173   169   177   160   160   177   177   138   146   146
19;08        124   152   165   160   146   152   160   152   169   160
19;18        160   160   169   169   152   160   152   160   171   171
19;28        160    30    51    37    51   160   152   160   160   169
19;38        152   169   160   160   160   100   169   167   158   152
19;48        162   169   169   181   160   160   152   146   160   160
19;58        160   160   160   169   160   167   160   167   160   175
20;08        177   163   162   160   160   169   169   169   169   152
20;18        160   152   152   146   160   165   165   160   152   160
20;28        169   160   160   160   152   167   156   152   152   152
20:38        160   160   160   160   167   167   160   175   160   160
20;48        156   160   160   160   169   160   160   160   169   177
20;58        177   169   152   169   167   160   167   169   156   160
21;08        160   177   169    75    73   146   152   124   110   167
21;18        150   160   152   152   167    65   297    35    22    22
21;28         22    22    59    59    35    65    30    43   132   205
21;38        177   169   177   191   197   205   209   181   195    22
21;48         22    22    22    22    30    22    30    22    22    22
21;58         22    22    30    22    22    30    35    65    51    22
22;08         22   167   195   189   177   177   177   189   181   205
22;18        195   181   177   177   173   169   173   177   181   177
22;28        169   169   169   177   181   169   177   169   169   160
22;38        160   160   167   160   169   175   169   169

AVERAGE CONC = 148.6 PPM AS C1 FOR  378 MINUTES
---------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM         PLANT NO 5        ATTN=500 MULT=5.186
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/26 05;44
--------------------------------------------------------------------------


05;44          45     61     61     53     45     53     53     61     61     67
05;54          67     81     75     67     67     81     96     89     92     81
06;04          96     89     81     81     89     96     81     96     96     89
06;14          81     89     89     89     81     81     81     89     81     89
06;24          89     89     96     96     96     96     89     96     89     96
06;34          89     89     89     81     89     96     89     96     89     89
06;44          81     89     96     89     96     96     81     96     89     96
06;54          89     96     96     96     96     89     89     89     96     89
07;04          96     89     96     81     81     96     81     81     96     89
07;14          89     96     96     89     89     89     89     96     96     96
07;24          96     89     96     89     81     89     81     81     89     89
07;34          96     89     89     89     96     89     96

AVERAGE CONC = 86.39 PPM AS C1 FOR  117 MINUTES
--------------------------------------------------------------------------


08;06          22     22     22     22     22     22     22     31     22     22
08;16          22     22     22     22     22     22     22     22     22     31
08;26          22     22     22     22     22     22     22     31     22     22
08;36          22     22     22     22     22     22     22     22     37

AVERAGE CONC = 23.35 PPM AS C1 FOR  39 MINUTES
--------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM          PLANT NO 5          ATTN=500 MULT=5.186
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/26 08;45
------------------------------------------------------------------------------

08;45       89   104   120   122   114    96    96    92   114   122
08;55      122    96   114    96    96    96   104    92    92    92
09;05      104    92    81    92    92    92    92    81    96    92
09;15       81    92    81    92    92    96    96    89    96    89
09;25       89    81    89    96    81    81    81    89    89    89
09;35       81    89    81    89    89    96    89    96    81    81
09;45       81    81    89    81    89    81    89    81    89    89
09;55       89    89    89    89    89    89    89    89    89    89
10;05       89    81    81    89    96    81    89    96    81    89
10;15       81    89    81    81    81    89    89    96    81    81
10;25       89    81    81    81    96    96    81    81    81    89
10;35       81    81    96    96    81    89    89    89    81    81
10;45       89    81    96    89    92   128   165   114    89    89
10;55       89    81    96    81    81    96    81    81    89    81
11;05       96    96    96    89    92    92    92    92    96    92
11;15       96    96    92    92    92    92    87    92    92    92
11;25       81    92    92    92    96    81    92    92    92    92
11;35       92    81    81    92    96    81    92    96    92    96
11;45       92    92    92    92    92    92    92    81    96    92
11;55       92    92    92    92    81    81    81    92    92    92
12;05       92    92    96    45    22    22    22    22    22    22
12;15       22    22    22    22    22    22    22    22    22    22
12;25       22    22    22    31    22    22    22    22    22    22
12;35       22    22    22    22    22    22    45    45    92   122
12;45      114   122   122   114   114   104   104    96    92    96
12;55       92    92    89    89    96    89    96    81    92    89
13;05       89    92    81    89    81    81    96    89    89    92
13;15       89    89    89    96    89    89    89    92    96    89
13;25       89    89    89    89    89    92    89    96    96    96
13;35       89    81    89    89    22    22    22    22    22    22
13;45       22    22    22    22    22    22    22    22    22    22
13;55       22    31    67   122   122   122   136   128   122   114
14;05      104    96    89    96    89    96   104    89    96    89
14;15       89    89    89    89    89    96    89    96    89    89
14;25       81    89    96    89    89    67

 AVERAGE CONC = 81.62 PPM AS C1 FOR  346 MINUTES
------------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM          PLANT NO 5         ATTN=500 MULT=5.186
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/26 16;24
--------------------------------------------------------------------------------


16;24           45      96     122      81      67      53      53      45      45      37
16;34           37      45      37      37      37      37      37      45      37      37
16;44           45      45      37      37      45      37      37      37      45      37
16;54           45      45      45      45      37      45      53      53      61      61
17:04           53      53      75      67      81      75      67      96      81      89
17;14           89      81      75      81      96      89      89      96     114      96
17;24          104      96     104      89      96     104      96     104     104      96
17;34           96      96     104     104      96     104     104      89      96      96
17;44           89      96      96      96      96      96      89      89      89      96
17;54           89      89      89      89      81      96      81      89      89      81
18:04           89      81      81      89      89      81      89      89      89      89
18;14           81      89      75      81      75      81      81      81      81      81
18;24           81      81      75      81      81      75      75      75      75      75
18;34           67      75      75      75      75

AVERAGE CONC = 75.26 PPM AS C1 FOR  135 MINUTES
--------------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM        PLANT NO 5       ATTN=200 MULT=2.074
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/26 23;23
---------------------------------------------------------------------------


23;23       115    111    105    111    109    118    115    109    115    115
23;33       115    109    111    111    115    124    115    118    111    118
23;43       115    121    109    118    111    111    129    121    115    115
23;53       115    111    111    109    118    111    115    115    115    118
00;03       111    127    127    121    111    111    115    115    124    118
00;13       115    111    121    118    118    115    121

AVERAGE CONC = 115.0 PPM AS C1 FOR  57 MINUTES
---------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM          PLANT NO 5          ATTN=200 MULT=1.984
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/27 04;01
--------------------------------------------------------------------------------


04;01            78       81       78       90      124      121      113      113      104      104
04;11           107      117      110      110      107      117      113      104      101      107
04;21           104      104      104      104      101      107      110      117      117      113
04;31           104      117      118      107      101      110      104      107      113      117
04;41           117      113      117      104      101      104      107      101      113      117
04;51           113      110      113      113      117      113      110      113      113      107
05;01           113      107      101      118      107      110      110      104      110      113
05;11           107      107      117      110      113      107      113      107      110      104
05;21           107      104      107      113      107      104      104      117      117      107
05;31           110      113      104      107      107      101      104    11.66    11.66    11.66
05;41         8.557    11.66    11.66       14       14    8.557    8.557    8.557    8.557    11.66
05;51         11.66    11.66    11.66    8.557    8.557    8.557    11.66    11.66    11.66    11.66
06;01         11.66    11.66    11.66    8.557    11.66    8.557    8.557    8.557    8.557    11.66
06;11         8.557    8.557    8.557    11.66    8.557    11.66    8.557    8.557       14    11.66
06;21         17.11    11.66    8.557    8.557    11.66       14    11.66    8.557       40       35
06;31           104      124      136      139      142      142      133      139      124      128
06;41           128      121      118      124      118      121      118      118      110      110
06;51           113      117      110      101      106      106      116      116      106      100
07:01           106      113      104      106      107      104      101      104      100      104
07;11           100      110      110      106      .107     110      113      110      101       99
07;21           107      116      110      113      116      113      104      113      110      104
07;31           113      106      100      110      116      113      117      113      110      107
07;41           110      106      118      106      104      142       86       99      100      100
07;51            99       99      104       99       99      100      104       99      101       99
08;01            99      101      104      106      100      100      104      104      104      100
08:11            99       99      104      104      106       99      100      106      106      104
08;21           100      106      106      106      100      100      104      104      104      110
08;31           110      100      104      104      104      101      118      116      110      110
08;41           104      110      100      104      106      100      110      121      133      127
08;51           139      136      136      141      139      136      132      136      139      127
09;01           124      124      124      129      129      139      136      136      132      129
09;11           132      127      129      124      129      139      129      121      118      118
09;21           124      116      121      118      132      129      124      129      121      136
09;31           127      127      139      132      139      127      127      132      132      118
09;41           121      116      127      129      124      132      121      124      127      136
09;51           127      121      127      139      136      132      129      132      132      129
10;01           129      124      132      139      127      132      121      132      124      124
10;11           141      129      132      136      127      129      132      127      124      132
10;21           124      129      136

 AVERAGE CONC = 100.2 PPM AS C1 FOR  383 MINUTES
--------------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM         PLANT NO 5        ATTN=200 MULT=1.984
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/27 13;21
------------------------------------------------------------------------------------------------------


13;21          26        26       113       113        95        82        72        67        60        54
13;31          58        54        49        49        49        49        52        47        47        47
13;41          47        49        47        44        44        44        47        49        44        44
13;51       11.66     11.66     8.557        24     17.11        14        24        21     11.66     11.66
14;01       17.11     11.66     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557
14;11       8.557     11.66     11.66     11.66     11.66     8.557     8.557     8.557     8.557     8.557
14;21       8.557     8.557     8.557     8.557     8.557     8.557     11.66     8.557     11.66        14
14;31          14     17.11        21        14     8.557     8.557     8.557     8.557     8.557     8.557
14;41       8.557     8.557     8.557     8.557     8.557     8.557     11.66     8.557     8.557     8.557
14;51       8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557
15;01       8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557
15;11       11.66        37        30        82       116        93        82        67        54        58
15;21          49        49        44        40        47        49        47        47        37        52
15;31          52        49        49        47        44        47        44        44        47        47
15;41          47        44        44        49        47        47        47        44        47        47
15;51          40        40        47        44        40        44        49        44        44        44
16;01          47        47        47        44        47        47        47        47        47        47
16;11          49        47        47        44        47        14     11.66     8.557     11.66     17.11
16;21          44        24        14        14        37        21     11.66     11.66     11.66     8.557
16;31       8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557
16;41       8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557
16;51       8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557
17;01       8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557
17;11       8.557     8.557     8.557     8.557     8.557     8.557     8.557     11.66     8.557     8.557
17;21       8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557     8.557
17;31       8.557     8.557     8.557     8.557     8.557     8.557

AVERAGE CONC = 25.25 PPM AS C1 FOR  256 MINUTES
------------------------------------------------------------------------------------------------------
```

```
CATALYTIC INCINERATOR PROGRAM             PLANT NO 5            ATTN=200 MULT=1.984
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/27 21;17
------------------------------------------------------------------------------------------------------------

21;17           83        83        81        83        14     11.66     11.66     11.66        14        14
21;27        11.66     11.66        32        21        24        21        14     17.11        21        14
21;37           14        14     17.11        14        14     11.66     17.11        21        14     11.66
21;47        11.66     11.66     11.66     11.66        14     11.66     11.66     8.557     11.66     11.66
21;57        11.66     11.66     11.66     11.66     11.66     11.66     8.557     8.557     11.66     11.66
22;07        11.66     11.66        40       104       132       132       118       100       100       100
22;17           93        93        89        86        95        89        86        86        81        86
22;27           82        82        78        86        82        81        82        82        82        82
22;37           81        80        81        81        82        81        80        81        81        82
22;47           82        86        82        82        86        93        86        89        80        86
22;57           82        82        86        86        82        86        80        86        86        89
23;07           82        89        80        82        86        86        82        82        82        82
23;17           86        86        86        14     11.66     11.66     11.66     8.557     11.66     11.66
23;27        8.557     11.66     8.557     11.66        14

AVERAGE CONC = 53.80 PPM AS C1 FOR  135 MINUTES
------------------------------------------------------------------------------------------------------------
```

APPENDIX F

LISTING OF EPA DRAFT REFERENCE METHOD 18 DATA

Raw EPA Method chromatogram data are maintained in the permanent project files and are not presented here. A summary of the results from these data are, however, presented in Table F-1.

TABLE F-1. SUMMARY OF EPA DRAFT REFERENCE METHOD 18 DATA -- INCINERATORS 20 AND 21

						Concentrations (ppmc) at Selected Retention Times (minutes)											
Incinerator	Date	Time	Sampling Location: Inlet or Outlet	Catalyst Temperature Set Point, °F	System Status: Steady or Unsteady	0-1.45	1.46-1.55	1.56-1.75	1.76-2.0	2-3	3-4	4-5	5-6	6-7	7-8	8+	Total ppmc
20	1/21	0429	O	700	S	33	32	13	4								82
		0511	O	700	U	3											3
		0608	O	700	U	33	54	19	9								115
		0638	O	700	S	48	134	49	5								236
		0703	O	700	S	27	41	13									81
		0738	I	700	S	17	30	11	8						45	60	171
		0914	I	700	U	42	82		8					45		26	203
		0943	I	700	U	14	25	6					82	23		65	215
		1014	I	700	S	14	28	6						33		60	141
		1040	I	700	S	3	10							61		125	199
		1119	I	700	S	17	13	6					3	121		60	220
		1145	I	700	S	17	24	10	5	3		7		30		57	153
		1307	O	700	S	26	35	13	2								76
		1402	I	700	U	21	21	7					8	36		81	174
		1448	O	700	U	27	30	8	8							48	121
		1600	O	725	S	24	18	15	8	8					40	40	153
		1803	O	725	S	24	33	15	9	18				10		30	139
		2007	O	725	U	5	10								17	140	172
		2037	O	725	U	12	7									495	514
		2230	I	725	S	43	20	24	28	47	5	7	40	299	393	670	1576
		2257	I	725	S	38	18	18	10				20	286	707	1030	2127
	1/22	0042	O	725	U	48	45	19	3	16					300	847	1278
		1654	O	750	S	31	31	14	6	3	3		2	18	159	150	417
		1755	O	750	S	35	19	18	13	11			4	20	88	186	394
	1/24	0056	O	750	U	28	36	11	7	4		5	14	90	136	150	481
		0118	O	750	U	21	52	17	16	10		8	28	149	77	140	518
		0210	I	750	U	41	23	24	21	20				8	27	80	244

TABLE F-1. (Continued)

Incinerator	Date	Time	Sampling Location: Inlet or Outlet	Catalyst Temperature Set Point, °F	System Status: Steady or Unsteady	0-1.45	1.46-1.55	1.56-1.75	1.76-2.0	2-3	3-4	4-5	5-6	6-7	7-8	8+	Total ppmc
21	1/25	1721	O	700	S	27	25	10	4					1	1		68
		1805	O	700	S	29	25	11	5					17	10	20	117
		1832	O	700	S	22	20	9	6					5	2	15	69
		1853	O	700	S	27	24	13	6	7				6	3	20	106
		1926	O	700	S	26	21	10	5					2	8	10	82
		1949	O	700	S	24	19	8	4					3	4	20	82
		2009	O	700	S	26	25	37	6					12	14	28	148
		2028	O	700	S	25	21	11	5					3	24	30	119
		2049	I	700	S	24	88	25	30	47	20	23	348	267	878	604	2354
		2144	I	700	U		23			2				107	776	730	1638
		2222	I	700	S	17	57	11	10	8	3	35	38	202	402	600	1383
		2247	I	700	S	14	44	19	7	11	7	23	194	674	358	680	2031
	1/26	0021	O	700	S	25	16	7									48
		0106	O	700	U	2											2
		0129	I	700	U		16								2	7	25
		0736	I	700	S	8	51					7	103		470	170	809
		2050	O	725	S	20		5							11	25	61
		2117	I	725	S	10	44		2		11		3	87	151	510	818
		2209	I	725	S	14	49			2	3	10		139	161	448	826
		2233	O	725	S	27		9	6					2	47	240	331
		2306	O	725	S	26		7	3						98	585	719
		2332	I	725	S	26	92	7	86		3	13	41	358	752	740	2118
		2358	I	725	S	16	48	7	3			8	17	93	328	540	1060
	1/27	1406	O	750	U												0
		2000	O	750	U	15		3									18
		2037	O	750	S	13		3									16
		2101	I	750	S	7	44				1	6	36	287	604	510	1495
		2228	I	750	S	9	47	6	7	26	5	11	27	300	566	210	1214
		2259	O	750	S	14		3	2				29	15	312	200	575

APPENDIX G

LISTING OF EPA REFERENCE METHOD 3 (EQUIVALENT) DATA

Tables G-1 and G-2 summarize the EPA Reference Method 3 (equivalent) data for incinerators 20 and 21, respectively.

TABLE G-1. SUMMARY OF EPA REFERENCE METHOD 3 (EQUIVALENT) DATA--INCINERATOR 20

Date	Time	Sampling Location	Press Status	Catalyst Temperature Setpoint	N_2 Vol. %	O_2 Vol. %	CO_2 Vol. %	Dry Molecular Weight
012183	0744	Inlet	On	371°C (700°F)	78.7	20.3	0.97	29.0
	0921	Inlet	On	371°C (700°F)	78.7	20.3	0.96	29.0
	1005	Inlet	Off	371°C (700°F)	78.3	21.5	0.21	28.9
	1025	Inlet	On	371°C (700°F)	78.7	20.3	1.00	29.0
	1515	Inlet	On	371°C (700°F)	78.8	20.3	0.93	29.0
	1523	Inlet	On	371°C (700°F)	78.8	20.3	0.91	29.0
	1529	Inlet	On	371°C (700°F)	78.6	20.5	0.84	28.9
	0443	Outlet	Off	371°C (700°F)	78.9	19.1	1.98	29.1
	0505	Outlet	Off	371°C (700°F)	78.2	20.2	1.62	29.1
	0604	Outlet	On	371°C (700°F)	78.6	20.2	1.22	29.0
	0635	Outlet	On	371°C (700°F)	78.4	20.4	1.17	29.0
	0652	Outlet	On	371°C (700°F)	79.5	19.2	1.30	29.0
	0716	Outlet	On	371°C (700°F)	79.2	19.4	1.42	29.0
	1144	Outlet	On	371°C (700°F)	79.5	19.3	1.19	29.0
	1209	Outlet	On	371°C (700°F)	79.2	19.4	1.44	29.0
	1458	Outlet	On	371°C (700°F)	79.8	19.0	1.17	28.9
	1505	Outlet	On	371°C (700°F)	77.6	21.4	1.06	29.0
	1535	Outlet	On	371°C (700°F)	79.7	19.5	0.75	28.9
012183	1827	Inlet	Off	385°C (725°F)	78.2	21.7	0.10	28.9
	1850	Inlet	On	385°C (725°F)	79.0	20.1	0.91	29.0
	1914	Inlet	On	385°C (725°F)	78.9	20.2	0.89	28.9
	1821	Outlet	Off	385°C (725°F)	79.1	19.3	1.63	29.0
	1840	Outlet	On	385°C (725°F)	78.7	19.7	1.59	29.0
	1908	Outlet	On	385°C (725°F)	79.4	19.2	1.36	29.0
012283	1746	Outlet	On	399°C (750°F)	79.1	19.3	1.63	29.0

TABLE G-2. SUMMARY OF EPA REFERENCE METHOD 3 (EQUIVALENT) DATA--INCINERATOR 21

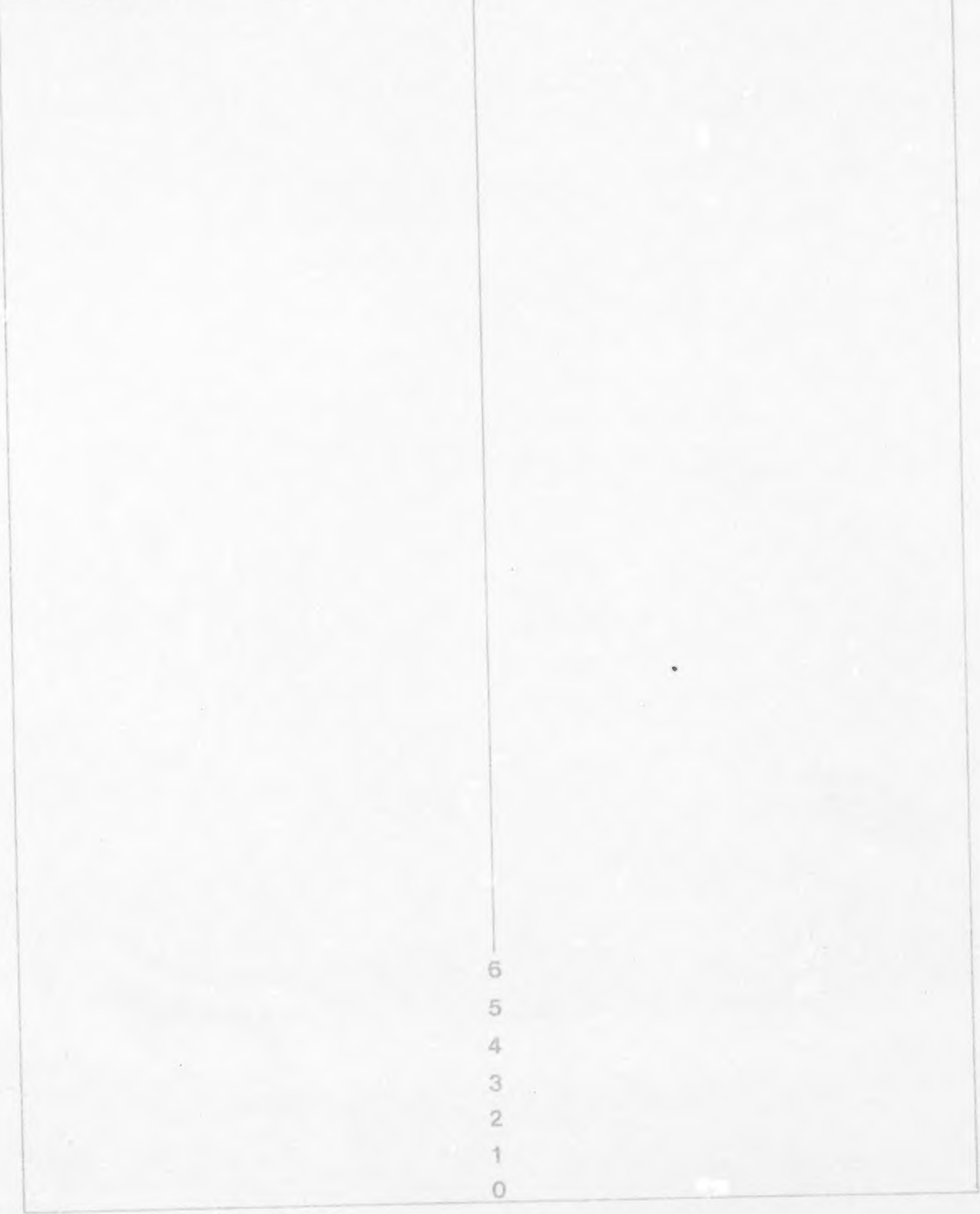
Date	Time	Sampling Location	Press Status	Catalyst Temperature Setpoint	N_2 Vol. %	O_2 Vol. %	CO_2 Vol. %	Dry Molecular Weight
012583	1907	Inlet	On	371°C (700°F)	78.6	20.7	0.69	28.9
	2050	Inlet	On	371°C (700°F)	78.5	20.8	0.63	28.9
	2335	Inlet	On	371°C (700°F)	78.6	20.7	0.70	28.9
012683	0034	Inlet	On	371°C (700°F)	78.6	20.6	0.74	28.9
	0117	Inlet	Off	371°C (700°F)	78.1	21.8	0.08	28.9
	0706	Inlet	On	371°C (700°F)	78.6	20.8	0.59	28.9
012583	1718	Outlet	On	371°C (700°F)	78.8	20.1	1.12	29.0
	2056	Outlet	On	371°C (700°F)	78.8	20.1	1.16	29.0
	2327	Outlet	On	371°C (700°F)	77.7	21.3	0.95	29.0
012683	0028	Outlet	On	371°C (700°F)	78.8	19.9	1.27	29.0
	0111	Outlet	Off	371°C (700°F)	78.5	20.9	0.60	28.9
	0659	Outlet	On	371°C (700°F)	78.7	20.3	1.03	29.0
012683	2142	Inlet	On	385°C (725°F)	78.6	20.7	0.68	28.9
	2236	Inlet	On	385°C (725°F)	78.6	20.7	0.74	29.0
	2334	Inlet	On	385°C (725°F)	78.7	20.5	0.73	28.9
	2130	Outlet	On	385°C (725°F)	78.8	20.0	1.13	29.0
	2220	Outlet	On	385°C (725°F)	78.9	19.9	1.18	29.0
	2327	Outlet	On	385°C (725°F)	78.8	20.0	1.19	29.0
	2348	Outlet	On	385°C (725°F)	79.2	19.9	0.95	29.0
012783	2056	Inlet	On	399°C (750°F)	78.5	20.8	0.63	28.9
	2304	Inlet	On	399°C (750°F)	78.7	20.9	0.37	28.9
	1253	Outlet	Off	399°C (750°F)	78.5	20.7	0.78	28.9
	2104	Outlet	On	399°C (750°F)	78.9	20.0	1.13	29.0
	2253	Outlet	On	399°C (750°F)	78.9	19.9	1.19	29.0

APPENDIX H

LISTING OF BYRON 401 FULL SCAN (FS) DATA

Listings of the Byron 401 Full Scan (FS) data, i.e., THC, NMHC, CO, CH_4. and CO_2, for the exhaust gas from incinerators 20 and 21 are provided in Sections H.1 and H.2, respectively.

H.1 INCINERATOR 20 OUTLET FS DATA



```
THERMAL INCINERATOR PROGRAM           PLANT NO 4          ATTN=500 MULT=5.601
 THC CONCENTRATIONS AS C1 IN  OUTLET <INC#20>  STARTING AT 01/20 10:54
------------------------------------------------------------------------------

10:54        294    299    310    301    307    321    57    40    40    40
12:54         35     42
AVERAGE CONC = 173.6 PPM AS C1 FOR  144 MINUTES
------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM           PLANT NO 4          ATTN=500 MULT=4.798
NMHC CONCENTRATIONS AS C1 IN  OUTLET <INC#20>  STARTING AT 01/20 10:54
------------------------------------------------------------------------------

10:54        294    303    301    322    314    344    73    38    13    34
12:54         56     56
AVERAGE CONC = 179.0 PPM AS C1 FOR  144 MINUTES
------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM           PLANT NO 4          ATTN=1000 MULT=11.69
  CO CONCENTRATIONS AS C1 IN  OUTLET <INC#20>  STARTING AT 01/20 10:54
------------------------------------------------------------------------------

10:54        523    647    596    509    546    541    23  4.59    64  4.59
12:54       9.17     14
AVERAGE CONC = 290 PPM AS C1 FOR  144 MINUTES
------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM           PLANT NO 4          ATTN=100 MULT=1.006
 CH4 CONCENTRATIONS AS C1 IN  OUTLET <INC#20>  STARTING AT 01/20 10:54
------------------------------------------------------------------------------

10:54         11   7.49     10     10     11     12  1.18  1.18  1.58  1.58
12:54       1.97   1.58
AVERAGE CONC = 5.881 PPM AS C1 FOR  144 MINUTES
------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM           PLANT NO 4          ATTN=20000 MULT=198.8
 CO2 CONCENTRATIONS AS C1 IN  OUTLET <INC#20>  STARTING AT 01/20 10:54
------------------------------------------------------------------------------

10:54      14810  14732  14421  14109  14577  14577  7327  8418  8574  8574
12:54       8886   8808
AVERAGE CONC = 11484 PPM AS C1 FOR  144 MINUTES
------------------------------------------------------------------------------
```

```
THERMAL INCINERATOR PROGRAM          PLANT NO 4          ATTN=500 MULT=5.393
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/21 08:15
--------------------------------------------------------------------------------

08:15        235    226

AVERAGE CONC = 230.4 PPM AS C1 FOR  24 MINUTES
--------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM          PLANT NO 4          ATTN=500 MULT=4.863
NMHC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/21 08:15
--------------------------------------------------------------------------------

08:15        1.91    309

AVERAGE CONC = 155.4 PPM AS C1 FOR  24 MINUTES
--------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM          PLANT NO 4          ATTN=1000 MULT=13.71
  CO CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/21 08:15
--------------------------------------------------------------------------------

08:15         48    495

AVERAGE CONC = 271.4 PPM AS C1 FOR  24 MINUTES
--------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM          PLANT NO 4          ATTN=100 MULT=1.037
 CH4 CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/21 08:15
--------------------------------------------------------------------------------

08:15        1.22   4.88

AVERAGE CONC = 3.051 PPM AS C1 FOR  24 MINUTES
--------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM          PLANT NO 4          ATTN=20000 MULT=192.8
 CO2 CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/21 08:15
--------------------------------------------------------------------------------

08:15        7562   7562

AVERAGE CONC = 7562 PPM AS C1 FOR  24 MINUTES
--------------------------------------------------------------------------------
```

```
THERMAL INCINERATOR PROGRAM          PLANT NO 4          ATTN=500 MULT=5.393
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/21 10:12
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------

10:12          72    254    269    254     23    296     42    260    269    260
12:12         245

AVERAGE CONC = 203.9 PPM AS C1 FOR  132 MINUTES
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
```

```
THERMAL INCINERATOR PROGRAM          PLANT NO 4          ATTN=500 MULT=4.863
NMHC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/21 10:12
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------

10:12         126    298    259    280     74    395     65    254    294    305
12:12         275

AVERAGE CONC = 238.5 PPM AS C1 FOR  132 MINUTES
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
```

```
THERMAL INCINERATOR PROGRAM          PLANT NO 4          ATTN=1000 MULT=13.71
  CO CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/21 10:12
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------

10:12         161    500    462    554     32   1064     91    500    457    522
12:12         559

AVERAGE CONC = 445.7 PPM AS C1 FOR  132 MINUTES
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
```

```
THERMAL INCINERATOR PROGRAM          PLANT NO 4          ATTN=100 MULT=1.037
 CH4 CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/21 10:12
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------

10:12        1.22     10   7.73   5.29   1.22     58   5.29   6.92    5.7   4.48
12:12        4.48

AVERAGE CONC = 10.02 PPM AS C1 FOR  132 MINUTES
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
```

```
THERMAL INCINERATOR PROGRAM        PLANT NO 4        ATTN=20000 MULT=192.6
 CO2 CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/21 10:12
--------------------------------------------------------------------------------


10:12       6654  12353  13838   7940   7789  16636  14216  14141  13990  13839
12:12      13460

AVERAGE CONC = 12277 PPM AS C1 FOR  132 MINUTES
--------------------------------------------------------------------------------
```

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```
THERMAL INCINERATOR PROGRAM         PLANT NO 4         ATTN=500 MULT=5.393
 THC CONCENTRATIONS AS C1 IN  OUTLET <INC#20>  STARTING AT 01/21 22:30
------------------------------------------------------------------------

22:30       254    258    260    254    260    269    260    258    290    258

AVERAGE CONC = 261.9 PPM AS C1 FOR  120 MINUTES
------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM         PLANT NO 4         ATTN=500 MULT=4.863
NMHC CONCENTRATIONS AS C1 IN  OUTLET <INC#20>  STARTING AT 01/21 22:30
------------------------------------------------------------------------

22:30       225    252    278    256    273    296    280    290    278    288

AVERAGE CONC = 271.7 PPM AS C1 FOR  120 MINUTES
------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM         PLANT NO 4         ATTN=1000 MULT=13.71
  CO CONCENTRATIONS AS C1 IN  OUTLET <INC#20>  STARTING AT 01/21 22:30
------------------------------------------------------------------------

22:30       591    613    484    554    436    575    543    586    479    542

AVERAGE CONC = 540.3 PPM AS C1 FOR  120 MINUTES
------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM         PLANT NO 4         ATTN=100 MULT=1.037
 CH4 CONCENTRATIONS AS C1 IN  OUTLET <INC#20>  STARTING AT 01/21 22:30
------------------------------------------------------------------------

22:30     3.66   4.88    5.7    5.7   4.88   4.48   4.07   4.07   4.48   4.48

AVERAGE CONC = 4.638 PPM AS C1 FOR  120 MINUTES
------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM         PLANT NO 4         ATTN=20000 MULT=192.8
 CO2 CONCENTRATIONS AS C1 IN  OUTLET <INC#20>  STARTING AT 01/21 22:30
------------------------------------------------------------------------

22:30     13763  14746  14141  14292  13914  13990  13460  15048  13990  14595

AVERAGE CONC = 14193 PPM AS C1 FOR  120 MINUTES
------------------------------------------------------------------------
```

```
THERMAL INCINERATOR PROGRAM        PLANT NO 4        ATTN=500 MULT=5.348
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/22 08:31
--------------------------------------------------------------------------

08:31        210    285    210    218    250

AVERAGE CONC = 234.4 PPM AS C1 FOR  60 MINUTES
--------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM        PLANT NO 4        ATTN=500 MULT=4.332
NMHC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/22 08:31
--------------------------------------------------------------------------

08:31         88    107     90     82    109

AVERAGE CONC = 95.12 PPM AS C1 FOR  60 MINUTES
--------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM        PLANT NO 4        ATTN=1000 MULT=14.21
  CO CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/22 08:31
--------------------------------------------------------------------------

08:31         89    117    117     50    100

AVERAGE CONC = 94.72 PPM AS C1 FOR  60 MINUTES
--------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM        PLANT NO 4        ATTN=100 MULT=1.166
 CH4 CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/22 08:31
--------------------------------------------------------------------------

08:31       1.37   1.37   1.37   1.37   1.37

AVERAGE CONC = 1.371 PPM AS C1 FOR  60 MINUTES
--------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM        PLANT NO 4        ATTN=20000 MULT=192.8
 CO2 CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/22 08:31
--------------------------------------------------------------------------

08:31       7562   7184   7108   7562     76

AVERAGE CONC = 5898. PPM AS C1 FOR  60 MINUTES
--------------------------------------------------------------------------
```

```
THERMAL INCINERATOR PROGRAM        PLANT NO 4        ATTN=500 MULT=5.363
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/24 02:26
--------------------------------------------------------------------------


02:26        250     69     69     80

AVERAGE CONC = 117.2 PPM AS C1 FOR  48 MINUTES
--------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM        PLANT NO 4        ATTN=500 MULT=4.512
NMHC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/24 02:26
--------------------------------------------------------------------------


02:26        173     28    223    205

AVERAGE CONC = 157.4 PPM AS C1 FOR  48 MINUTES
--------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM        PLANT NO 4        ATTN=1000 MULT=13.42
  CO CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/24 02:26
--------------------------------------------------------------------------


02:26        158     16   5.26     21

AVERAGE CONC = 50.00 PPM AS C1 FOR  48 MINUTES
--------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM        PLANT NO 4        ATTN=100 MULT=1.116
 CH4 CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/24 02:26
--------------------------------------------------------------------------


02:26         12   1.31   1.31   1.75

AVERAGE CONC = 4.049 PPM AS C1 FOR  48 MINUTES
--------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM        PLANT NO 4        ATTN=20000 MULT=292.8
 CO2 CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/24 02:26
--------------------------------------------------------------------------


02:26       8192     80    239     80

AVERAGE CONC = 2147. PPM AS C1 FOR  48 MINUTES
--------------------------------------------------------------------------
```

```
THERMAL INCINERATOR PROGRAM         PLANT NO 4          ATTN=500 MULT=5.363
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/24 03:27
-------------------------------------------------------------------------------

03:27          65     86    225    202    225    233    210    219    210    196
05:27         210    126    147    120    257    242     86     78     65     46
07:27          72    210     78     99     84     86     78     80     86     86
09:27          93     84     69     69     63     84     86     95    265    225
11:27         156    181     69     72     46

AVERAGE CONC = 130.3 PPM AS C1 FOR  540 MINUTES
-------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM         PLANT NO 4          ATTN=500 MULT=4.512
NMHC CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/24 03:27
-------------------------------------------------------------------------------

03:27         104    104     23     23     23     53     42     55     50     64
05:27          65     41    182    311    299    182     80    168    248    315
07:27         331    345    175    267    292    308    267    299    288    255
09:27         239    241    198    179    157    163    140    136 OVRNGE    203
11:27          27     14     12     92    159

AVERAGE CONC = 164.1 PPM AS C1 FOR  540 MINUTES   (1 OVERANGED POINTS):

-------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM         PLANT NO 4          ATTN=500 MULT=6.713
  CO CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/24 03:27
-------------------------------------------------------------------------------

03:27        2.63   2.63    116     97    105    113    108    103     97     97
05:27          97   2.63   2.63     66    116    103   2.63   2.63   2.63   2.63
07:27        2.63    124   2.63   2.63   2.63   2.63   2.63   2.63   2.63   2.63
09:27        2.63   2.63   2.63   5.26   5.26   5.26     11    7.9    497    155
11:27         105    111   2.63   2.63   2.63

AVERAGE CONC = 51.22 PPM AS C1 FOR  540 MINUTES
-------------------------------------------------------------------------------
```

```
THERMAL INCINERATOR PROGRAM        PLANT NO 4        ATTN=100 MULT=1.116
 CH4 CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/24 03:27
-----------------------------------------------------------------------------


03:27        5.69   3.07    3.5   2.63   1.75   2.63   3.07   3.07   3.07    3.5
05:27        4.82   1.31   1.31   1.31   4.82    3.5   1.31   1.31   1.31   1.31
07:27        1.31   7.44   1.31   1.31   1.31   1.31   1.31   1.31   1.31   1.31
09:27        1.31   1.31   1.31   1.31   1.31   1.31   3.07   4.82     33     18
11:27          13   8.76   1.31   1.31   1.31

AVERAGE CONC = 3.677 PPM AS C1 FOR  540 MINUTES
-----------------------------------------------------------------------------
```

```
THERMAL INCINERATOR PROGRAM        PLANT NO 4        ATTN=20000 MULT=202.8
 CO2 CONCENTRATIONS AS C1 IN  OUTLET (INC#20)  STARTING AT 01/24 03:27
-----------------------------------------------------------------------------


03:27         318   8749   6920   7715   7238   7954   6681   8192   7954   6681
05:27        6920    239    239   8988   7795    318    239     80     80     80
07:27       16862    318     80    477    239     80     80    477     80    239
09:27          80    239     80     80     80    239     80    239 OVRNGE   6920
11:27        7238    318     80    239    239

AVERAGE CONC = 2919. PPM AS C1 FOR  540 MINUTES   (1 OVERANGED POINTS):

-----------------------------------------------------------------------------
```

H.2 INCINERATOR 21 OUTLET FS DATA

6
5
4
3
2
1
0

```
THERMAL INCINERATOR PROGRAM           PLANT NO 5          ATTN=500 MULT=5.023
 THC CONCENTRATIONS AS C1 IN  RADIAN AUDIT <24JAN83>  STARTING AT 01/25 23:09
------------------------------------------------------------------------------

23:09          177     177     169     177      43      30     189     183      22      20
01:09           22      22      22      22      20     189      22

AVERAGE CONC = 88.48 PPM AS C1 FOR  204 MINUTES
------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM           PLANT NO 5          ATTN=500 MULT=3.063
NMHC CONCENTRATIONS AS C1 IN  RADIAN AUDIT <24JAN83>  STARTING AT 01/25 23:09
------------------------------------------------------------------------------

23:09           89     106     103     107     106      30     1.2      88     105     1.2
01:09         4.81     1.2     1.2     3.6     1.2     1.2      84

AVERAGE CONC = 48.96 PPM AS C1 FOR  204 MINUTES
------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM           PLANT NO 5          ATTN=2000 MULT=26.20
  CO CONCENTRATIONS AS C1 IN  RADIAN AUDIT <24JAN83>  STARTING AT 01/25 23:09
------------------------------------------------------------------------------

23:09         1006    1027    1017    1006     914      72      10    1078    1048      10
01:09           21     195      31      10      62      10    1037

AVERAGE CONC = 503.2 PPM AS C1 FOR  204 MINUTES
------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM           PLANT NO 5          ATTN=100 MULT=1.279
 CH4 CONCENTRATIONS AS C1 IN  RADIAN AUDIT <24JAN83>  STARTING AT 01/25 23:09
------------------------------------------------------------------------------

23:09           48      38      42      40      34    2.51    9.03      45      43    3.01
01:09         2.01    2.01    2.51    3.01    4.01    3.51      59

AVERAGE CONC = 22.33 PPM AS C1 FOR  204 MINUTES
------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM           PLANT NO 5          ATTN=20000 MULT=209.4
 CO2 CONCENTRATIONS AS C1 IN  RADIAN AUDIT <24JAN83>  STARTING AT 01/25 23:09
------------------------------------------------------------------------------

23:09        11498   11005   11580   10841    4681    4845   11662   11170    5420    5092
01:09         5749    5502    5502    5092    5831   14619   12484

AVERAGE CONC = 8386. PPM AS C1 FOR  204 MINUTES
------------------------------------------------------------------------------
```

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```
THERMAL INCINERATOR PROGRAM          PLANT NO 5          ATTN=500 MULT=5.186
 THC CONCENTRATIONS AS C1 IN   RADIAN AUDIT (24JAN83)   STARTING AT 01/26 18:54
---------------------------------------------------------------------------------

18:54          69      98

AVERAGE CONC = 83.37 PPM AS C1 FOR  24 MINUTES
---------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM          PLANT NO 5          ATTN=500 MULT=4.566
NMHC CONCENTRATIONS AS C1 IN   RADIAN AUDIT (24JAN83)   STARTING AT 01/26 18:54
---------------------------------------------------------------------------------

18:54          30      81

AVERAGE CONC = 55.49 PPM AS C1 FOR  24 MINUTES
---------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM          PLANT NO 5          ATTN=2000 MULT=22.82
  CO CONCENTRATIONS AS C1 IN   RADIAN AUDIT (24JAN83)   STARTING AT 01/26 18:54
---------------------------------------------------------------------------------

18:54         233     188

AVERAGE CONC = 210.3 PPM AS C1 FOR  24 MINUTES
---------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM          PLANT NO 5          ATTN=100 MULT=1.127
 CH4 CONCENTRATIONS AS C1 IN   RADIAN AUDIT (24JAN83)   STARTING AT 01/26 18:54
---------------------------------------------------------------------------------

18:54          21      15

AVERAGE CONC = 17.89 PPM AS C1 FOR  24 MINUTES
---------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM          PLANT NO 5          ATTN=20000 MULT=198.8
 CO2 CONCENTRATIONS AS C1 IN   RADIAN AUDIT (24JAN83)   STARTING AT 01/26 18:54
---------------------------------------------------------------------------------

18:54        7327    5300

AVERAGE CONC = 6313. PPM AS C1 FOR  24 MINUTES
---------------------------------------------------------------------------------
```

```
THERMAL INCINERATOR PROGRAM          PLANT NO 5          ATTN=200 MULT=2.074
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/26 21:05
-------------------------------------------------------------------------------


21:05          94      98      94      94      94      99     109     121     111     114
23:05         111     118

AVERAGE CONC = 104.9 PPM AS C1 FOR  144 MINUTES
-------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM          PLANT NO 5          ATTN=200 MULT=1.826
NMHC CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/26 21:05
-------------------------------------------------------------------------------


21:05          59      65      67      70      69      69      81      79      77      90
23:05          83      90

AVERAGE CONC = 74.83 PPM AS C1 FOR  144 MINUTES
-------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM          PLANT NO 5          ATTN=500 MULT=5.707
  CO CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/26 21:05
-------------------------------------------------------------------------------


21:05         468     450     432     432     430     445     510     539     519     537
23:05         517     537

AVERAGE CONC = 484.6 PPM AS C1 FOR  144 MINUTES
-------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM          PLANT NO 5          ATTN=100 MULT=1.127
 CH4 CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/26 21:05
-------------------------------------------------------------------------------


21:05          32      34      33      32      31      33      33      42      37      38
23:05          35      38

AVERAGE CONC = 34.69 PPM AS C1 FOR  144 MINUTES
-------------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM          PLANT NO 5          ATTN=20000 MULT=198.3
 CO2 CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/26 21:05
-------------------------------------------------------------------------------


21:05       10289   10679   10289   10211   11225   11225   10835   10991   11614   10991
23:05       10601      78

AVERAGE CONC = 9918. PPM AS C1 FOR  144 MINUTES
-------------------------------------------------------------------------------
```

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```
THERMAL INCINERATOR PROGRAM        PLANT NO 5        ATTN=200 MULT=1.984
 THC CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/27 18:01
--------------------------------------------------------------------------


18:01        67     47     60     67     63     75     78     78     78     75
20:01        82     86     82     89     72     78     78

AVERAGE CONC = 73.85 PPM AS C1 FOR  204 MINUTES
--------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM        PLANT NO 5        ATTN=200 MULT=1.733
NMHC CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/27 18:01
--------------------------------------------------------------------------


18:01        33     29     43     48     47     60     67     60     67     58
20:01        69     70     65     69     51     55     53

AVERAGE CONC = 55.55 PPM AS C1 FOR  204 MINUTES
--------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM        PLANT NO 5        ATTN=500 MULT=5.624
  CO CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/27 18:01
--------------------------------------------------------------------------


18:01       276    187    346    386    379    457    472    457    479    454
20:01       481   2.21    483    487    432    474    452

AVERAGE CONC = 394.3 PPM AS C1 FOR  204 MINUTES
--------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM        PLANT NO 5        ATTN=100 MULT=1.037
 CH4 CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/27 18:01
--------------------------------------------------------------------------


18:01        32     26     17     18     16     20     22     17     18     18
20:01        23     23     20     21     19     22     22

AVERAGE CONC = 20.84 PPM AS C1 FOR  204 MINUTES
--------------------------------------------------------------------------


THERMAL INCINERATOR PROGRAM        PLANT NO 5        ATTN=20000 MULT=187.2
 CO2 CONCENTRATIONS AS C1 IN  OUTLET (INC #21)  STARTING AT 01/27 18:01
--------------------------------------------------------------------------


18:01      9398   9692  10573   9986   9325   9839   9618   9692   9839   9692
20:01     10573   9472  10059  10793    220  10059   9692

AVERAGE CONC = 9324. PPM AS C1 FOR  204 MINUTES
--------------------------------------------------------------------------
```

APPENDIX I

LISTING OF EPA REFERENCE METHOD 2 DATA

Tables I-1 and I-2 summarize the EPA Reference Method 2 data for incinerators 20 and 21, respectively.

TABLE I-1. SUMMARY OF EPA REFERENCE METHOD 2 DATA--INCINERATOR 20

Date	Start Time	Sampling Location	Press Status	Catalyst Temperature Setpoint	Volumetric Flow Rate, Wet
012183	0945	Inlet	On	371°C (700°F)	1.26 Nm^3/sec (2660 scfm)
012183	1600	Inlet	On	385°C (725°F)	1.24 Nm^3/sec (2620 scfm)
012183	1900	Inlet	On	385°C (725°F)	1.29 Nm^3/sec (2740 scfm)
012383	1618	Inlet	On	399°C (750°F)	1.20 Nm^3/sec (2550 scfm)
012483	1800	Inlet	On	399°C (750°F)	1.25 Nm^3/sec (2650 scfm)
012483	1825	Outlet[a]	On	399°C (750°F)	1.15 Nm^3/sec (2440 scfm)

[a] Sampling ports do not conform to EPA Reference Method 1 requirements.

TABLE I-2. SUMMARY OF EPA REFERENCE METHOD 2 DATA--INCINERATOR 21

Date	Start Time	Sampling Location	Press Status	Catalyst Temperature Setpoint	Volumetric Flow Rate, Wet[a]
012583	2330	Outlet	On	371°C (700°F)	2.18 Nm^3/sec (4610 scfm)
012683	0615	Inlet, east leg	On	371°C (700°F)	1.08 Nm^3/sec (2280 scfm)
012683	0634	Inlet, west leg	On	371°C (700°F)	1.13 Nm^3/sec (2390 scfm)
012683	2235	Inlet, west leg	On	385°C (725°F)	1.10 Nm^3/sec (2320 scfm)
012683	2325	Inlet, east leg	On	385°C (725°F)	1.08 Nm^3/sec (2280 scfm)
012783	0013	Outlet	On	385°C (725°F)	2.15 Nm^3/sec (4560 scfm)
012783	2106	Inlet, west leg	On	399°C (750°F)	1.09 Nm^3/sec (2300 scfm)
012783	2232	Inlet, east leg	On	399°C (750°F)	1.05 Nm^3/sec (2230 scfm)

[a] Incinerator 21 processes SLA from dual printing lines; each of the two SLA flows was measured before the flows teed together at the incinerator inlet. The incinerator has a single outlet flow.

APPENDIX J

LISTING OF EPA REFERENCE METHOD 4 DATA

Tables J-1 and J-2 summarize the EPA Reference Method 4 data for incinerators 20 and 21, respectively.

TABLE J-1. SUMMARY OF EPA REFERENCE METHOD 4 DATA--INCINERATOR 20

Date	Start Time	Sampling Location	Press Status	Catalyst Temperature Setpoint	Moisture Content, %
012183	0933	Outlet	Varied[a]	371°C (700°F)	8.8
012183	1718	Outlet	On	385°C (725°F)	5.3
012183	1858	Inlet	On	385°C (725°F)	4.3

[a] Press was on during 89 percent of the sampling period.

TABLE J-2. SUMMARY OF EPA REFERENCE METHOD 4 DATA--INCINERATOR 21

Date	Start Time	Sampling Location	Press Status	Catalyst Temperature Setpoint	Moisture Content, %
012683	0212	Outlet	On	371°C (700°F)	4.2[a]
012683	0721	Inlet	On	371°C (700°F)	2.6[a]
012683	2223	Inlet	On	385°C (725°F)	---[b]
012783	0029	Outlet	On	385°C (725°F)	1.4[a]
012783	1554	Outlet	On	399°C (750°F)	3.2
012783	2055	Inlet	On	399°C (750°F)	3.6

[a] Data suspect -- test aborted early when press shut off for extended period.

[b] Data not available -- impinger contents not weighed prior to extraction.

APPENDIX K

LISTING OF GC/MS DATA

Raw GC/MS data are maintained in the permanent project files and are not presented here. A summary of the results from these data are, however, presented in Table K-1.

TABLE K-1. SUMMARY OF GC/MS DATA--INCINERATORS 20 AND 21

Compound	Incinerator 20 Concentrations, ppmc[a]		Incinerator 21 Concentrations, ppmc[a]	
	Inlet	Outlet	Inlet	Outlet
Gas-Phase Analysis				
C_4-C_7 alkanes	0	0	0	4
C_7-C_{14} alkanes	10	3	70	10
Cycloalkanes	1	0	9	1
C_4-C_{12} alkenes	0	7	0	2
Benzene	6	6	4	5
Toluene	7	6	4	2
Ethanol	0	0	4	5
Methylene chloride	2	0	1	0.1
Furan	0	2	0	0.6
Chlorobenzene	0	2	0	0.2
Naphthalene	1	0	0	0
Liquid-Phase (Extracts) Analysis[b]				
C_{13} alkane	5	0.1	5	0.1
C_{14} alkane	20	0.4	10	0.6
C_{15} alkane	20	0.8	20	2
C_{16} alkane	6	0.3	10	1
C_{17} alkane	2	0.2	5	1
TOTAL	80	30	100	30

[a] All concentrations, including totals, are expressed to one significant figure due to the qualitative nature of GC/MS analysis.

[b] Extracts resulting from aborted (suspect) moisture sampling tests as defined in Table J-2 are not included.

APPENDIX L

EXAMPLE CALCULATIONS

Methods used to calculate incinerator hydrocarbon destruction efficiency, energy recovery, and natural gas usage are presented in the following subsections.

L.1 HYDROCARBON DESTRUCTION EFFICIENCY

Hydrocarbon destruction efficiency is based on inlet and outlet VOC mass rates, as follows:

$$DE = \frac{M_{in} - M_{out}}{M_{in}} \times 100\% \qquad \text{(L-1)}$$

where DE = destruction efficiency, %

M_{in} = inlet hydrocarbon mass rate, gC/sec

M_{out} = outlet hydrocarbon mass rate, gC/sec

Hydrocarbon mass rates are based upon measured hydrocarbon concentrations and gas flow rates:

$$M = \frac{(V)\text{moles C}}{10^6 \text{ moles gas}} \times \frac{12\text{g C}}{\text{mole C}} \times \frac{\text{mole gas}}{0.0237 \text{ m}^3 \text{ gas}} \times \frac{(Q)\text{m}^3 \text{ gas}}{\text{sec}} \qquad \text{(L-2)}$$

where M = hydrocarbon mass rate (inlet or outlet), gC/sec

V = hydrocarbon concentration (inlet or outlet), ppmc

Q = gas flow rate (inlet or outlet), Nm^3/sec

Throughout this report, standard or normal conditions refer to those existing at 1 atmosphere of pressure and 15.6°C (60°F).

L.2 ENERGY RECOVERY

The incinerator energy recovery is defined as the percentage of heat provided by the heat recovery system of the total required to raise the inlet SLA temperature to the catalyst inlet temperature:

$$ER = \frac{Q_{HEX}}{Q_{TOTAL}} \times 100\% \qquad (L-3)$$

where ER = energy recovery, %

Q_{HER} = heat added to the inlet SLA by heat exchange with the incinerator exhaust gas, J/sec

Q_{TOTAL} = heat necessary to raise the inlet SLA temperature to the catalyst inlet temperature, J/sec

The above equation is solved by making the following assumptions and substitutions:

$$ER = \frac{mCp\left(T_{SLA,HEXout} - T_{SLA,HEXin}\right)}{mCp\left(T_{SLA,catin} - T_{SLA,HEXin}\right)} \times 100\% \qquad (L-4)$$

where m = mass flow rate of SLA, gmole/sec

Cp = specific heat of SLA at the elevated temperatures, J/gmole°K

$T_{SLA,HEXout}$ = temperature of the SLA exiting the heat exchange, °K

$T_{SLA,HEXin}$ = temperature of the SLA entering the heat exchanger, °K

$T_{SLA,catin}$ = temperature of the SLA entering the catalyst bed, °K

Of the above temperatures, $T_{SLA,HEXout}$ was not measured. It was calculated by performing an energy balance around the heat exchanger:

$$mCp\ (T_{SLA,HEXout} - T_{SLA,HEXin}) = mCp\ (T_{exh,HEXin} - T_{exh,HEXout}) \quad \text{(L-5)}$$

where $T_{exh,HEXin}$ = temperature of the exhaust gas entering the heat exchanger, °K

$T_{exh,HEXout}$ = temperature of the exhaust gas exiting the heat exchanger, °K

The SLA and exhaust gas mass rates are assumed to be equal for this calculation, since the contribution by the fuel gas to the exhaust gas mass rate is negligible. Specific heats of the inlet and outlet streams are also assumed to be equal over the measured temperature range.

L.3 NATURAL GAS USAGE

Natural gas usage was calculated for both incinerators; the gas flow totalizer on incinerator 20 was malfunctioning during the test program, and readings on the incinerator 21 flow totalizer were not taken during long periods of steady-state operation.

Natural gas energy consumption was calculated as follows:

$$Q_{gas} = mCp\ (T_{SLAcatin} - T_{SLA,HEXout}) \quad \text{(L-6)}$$

where Q_{gas} = natural gas energy usage, J/sec

m = SLA mass flow rate, gmole/sec

Cp = SLA specific heat, J/gmole-°K

The specific heat was calculated based on the composition of the inlet SLA:

$$Cp = \sum_{i-1} X_i\ Cp_i \quad \text{(L-7)}$$

where X_i = molar fraction of component i

Cp_i = specific heat of component i, J/gmole-°K

The X_i values were obtained from the Method 3 (equivalent) and Method 4 data. The Cp_i values used were temperature-dependent (L-1).

Natural gas flow rate was determined based upon the higher heating value, as quoted by the local supplier (L-2):

$$F_{gas} = \frac{Q_{gas}}{1040\ \text{Btu/scf}} \times \frac{\text{Nm}^3}{35.3\ \text{scf}} \times \frac{\text{Btu}}{1055\ \text{J}} \qquad \text{(L-8)}$$

where F_{gas} = natural gas flow rate, Nm^3/sec.

L.4 REFERENCES

L-1 Chemical Engineers' Handbook, Fifth Edition, R.H. Perry and C.H. Chilton, Eds., McGraw-Hill Book Company, New York, New York, 1973, p. 3-130.

L-2 Personal communication with Mr. Phil Bass, Southern California Gas Co., December 15, 1982.